BETTER BUILT THAN MAIN LINE LOCOMOTIVES

Compare the Life—

A MAIN LINE railroad locomotive goes out for a reasonable day's run—it is cleaned and washed and oiled—petted and pampered.

Consider the Porter in a quarry or gravel pit—long, hard shifts over uneven track—little care or attention, as a rule—the railroad locomotive requires more care in a week than the Porter does in six months, and the chances are the Porter will outlast it in service by a good many years.

Porter locomotives are specially built for quarry and industrial work—and although we build up to 120 tons—we do not build for main line railroads.

The building of industrial locomotives is a highly specialized business—the finest, best built locomotives made today—are locomotives built for industry.

H. K. PORTER COMPANY

PITTSBURGH PENNSYLVANIA

PORTER "better built" locomotives

FROM CAR TO HOPPER
VIA
THE INDUSTRIAL

THERE'S only one way you can cinch these large gravel deals that slip by you.

Of course, there are these points to consider—gravel, like everything else, must be delivered at a certain specified date. This is the big thing—service to your customers. A satisfied customer means repeat business.

The next thing to consider is your pocketbook. Are you going to gain financially? This point rests with you. It's a question of whether you have the right or wrong equipment. Whether it is efficient or deficient.

INDUSTRIAL cranes from the type D all purpose crawler, thru the largest locomotive cranes are filling many a pit operator's wallet. They are built for service and they give service.

Write our nearest representative for full information or wire him and arrange an appointment. He is glad to assist you.

Crawling Tractor Crane, Shovels, Draglines, Locomotive Cranes, 5 to 75 tons, Wrecking Cranes 75 to 200 tons, Freight Cranes, Transfer Tables, Railsaws, Pile Drivers, Clamshell Buckets, Steam Pile Hammers.

INDUSTRIAL WORKS: BAY CITY, MICHIGAN

BRANCHES:

Atlanta, Ga. Hurt Bldg. — Chicago, Ill. McCormick Bldg. — Cincinnati, Ohio Dixie Terminal Bldg. — Detroit, Mich. Book Building

New Orleans, Louisiana Whitney Central Bldg. — New York City 50 Church St. — Philadelphia, Pa. Packard Building

Pittsburgh, Pennsylvania Federal Reserve Bldg. — San Franisco, Calif. Monadnock Building — St. Louis, Mo. Railway Exchange

Pit and Quarry

Published Every Other Wednesday for Producers and Manufacturers of Sand, Gravel, Stone, Cement, Gypsum, Lime and Other Non-Metallic Minerals.

Subscription price $5 for 3 years; $2 for 1 year. Single copies 25c
Canadian and Foreign Subscriptions $1 additional for each year

Copyright 1927 by Complete Service Publishing Company

Vol. 14 CHICAGO, ILL., JULY 20, 1927 No. 8

FEATURE CONTENTS

Metallurgical Limestone 39
How limestone is used in metallurgy is told by Oliver Bowles in this article.

Sand, Gravel and Crushed Stone Produced Economically by Same Concern..... 43
F. A. Westbrook visits the Pompton Crushed Stone and the Pompton Sand and Gravel Company of Pompton, New Jersey.

Asphalt Paving Mixtures..... 50
A. W. Dow explains the theory and practice.

Dyer and Kane Cut Operating Costs by Effective Maintenance 55
An illustrated article about the operation at Ridgefield, New Jersey.

Strengthening and Weakening of Mortars..... 59
Dr. Ing. Heinrich Luftschitz discusses the important factors.

Limited Storage Area Problem Solved by Eastern Trap Rock Company..... 67
George Ransom describes the operations of a plant at Clifton, New Jersey.

Good Clean Aggregate Key to Growth of Oak Hill Gravel Company..... 71

Metallurgical Control of Foundry Sands..... 73
L. B. Thomas presents a practical treatise on this subject.

Crushers and Their Component Parts..... 81
The second article of a series by Wm. T. W. Miller. Jaws and cheek plates are discussed in this number.

Pit and Quarry Foreign Digest 93

Intimate News of Men and Plants..... 95

News of Equipment Manufacturers..... 101

Next Issue August 3, 1927

COMPLETE SERVICE PUBLISHING COMPANY
538 S. Clark St., Chicago, Ill.
Publishers of
PIT AND QUARRY and *Pit and Quarry* HANDBOOK

HARRY W. BAUMGARTNER, President
V. E. LARSEN, Vice-President
S. E. COLE, Eastern Representative
90 West Street, New York
Ph. Rector 1166

HAROLD W. MUNDAY, Editor
ROBERT MAWSON, Associate Editor
GEORGE B. MASSEY, Associate Editor
F. A. WESTBROOK, Associate Editor
E. D. ROBERTS, Associate Editor

ONLY THE BARBER-GREENE HAS THE DISC-FEED—*AND FLOATING BOOM*

Moving the Pile Fast
—from the Ground Up

Just point a Barber-Greene Loader at a pile of material, and things start moving fast.

Two broad, revolving discs with a knack of getting at the bottom of things glide into and under the pile. They skim the ground and feed each hungry bucket a full load.

And when the going gets rough the floating boom keeps the strains and twists from getting to the loader chassis.

These are the things that keep both the "25" and the "42" sailing through many years of fast loading—without trouble and without high repair costs.

BARBER-GREENE COMPANY
492 W. PARK AVE. AURORA, ILLINOIS

25 Loaders 42

Barber-Greene

Barber-Greene Loaders

Representatives in 50 Cities
DISC FEED LOADERS VERTICAL BOOM DITCHERS
STANDARDIZED PORTABLE AND PERMANENT BELT CONVEYORS
SNOW LOADERS CAR UNLOADERS COAL LOADERS

This coupon will bring you a copy of "Loading Layouts"—which shows how others are handling jobs similar to your own.

"Loading Layouts" contains many interesting loading jobs which Barber-Greene men ran across last year in various sections of the country.

Send for your copy today. It may show you the way to faster, cheaper loading.

BARBER-GREENE COMPANY
492 W. Park Ave., Aurora, Ill.

Name.....

Address.....

City.....

State.....

Pit and Quarry

Vol. 14 CHICAGO, ILL., JULY 20, 1927 No. 8

MORE FEDERAL FUNDS NEEDED FOR AGRICULTURE

WHATEVER form of farm relief is finally adopted by the federal government, it should be supplemented by more funds for agricultural research and extension work, declared Charles J. Brand, executive secretary and treasurer of The National Fertilizer Association, in a statement issued July 18th. His statement pointed out that the government's annual budget provides only 10 cents per man, woman and child in the United States for the research and extension of the U. S. Department of Agriculture all over the country, whereas "promotion of marine transportation" gets 54 cents and "national defense" gets $4.65 per capita.

The important problem of how to make the soil produce the country's food and raw materials for clothing and shelter most profitably for the farmer, and therefore most satisfactorily for the nation, is allotted only one-half cent per capita, whereas over four-fifths of a cent is spent for enforcement of the narcotic and prohibition acts alone. At the present rate of teaching farmers the new, profit-making practices gleaned by the present limited research, he said "it will take from 25 to 50 years to get where we might well be in 5 or 10 years with recourse to well-grounded research and carefully planned and effectively conducted demonstrations and teaching."

Mr. Brand speaks of federal appropriations, research and extension work with authority, for he was affiliated for nearly twenty years with the Department of Agriculture, and as the first chief of the Bureau of Markets organized that important branch of government service to agriculture. That bureau is now known as the Bureau of Agricultural Economics. Mr. Brand was consulting specialist in marketing when he left the department two years ago to take his present position.

"Many persons are under the misapprehension that vast sums are already expended for research and extension by the Department of Agriculture," he stated. "As a matter of fact, Secretary Jardine in his last annual report shows a total expenditure for the fiscal year ended June 30, 1926, of $157,485,660, but this included almost $100,000,000 for road building, which can not by any stretch of imagination be regarded as a real agricultural expenditure.

"The total expenditures for all the regular work of the Department amounted to $44,574,388. Of this amount only $393,876 was devoted to the Bureau of Soils, and $240,601 to the Fixed Nitrogen Research Laboratory. The appropriation for Soil Fertility Investigations, a branch of the Bureau of Plant Industry, was $66,200. The whole cost of work of soil fertility, soil surveys, fertilizer chemistry and nitrogen fixation was, therefore, $600,677. Of the total amount expended for regular work, $10,300,000 was devoted to research and $2,300,000 for extension. In other words, the Department, as such, spends a trifle over 10 cents per capita for research and extension combined, and about one-half cent per capita for soil science in its various aspects."

With agriculture now producing bountiful supplies of practically all crops, there is no justification for further research as a means of producing more in the aggregate, but "we need to produce what we make at less cost in order to insure a fair profit. The slogan of the fertilizer industry is 'Fewer Acres with Greater Profit,' and this is the thought that lies behind it.

"The government can do no one thing that would be more helpful to agriculture than to undertake a nation-wide program of research and demonstration to show the economic advantage of the use of commercial plant foods. For instance, the Department of Agriculture itself has proved, through its surveys, that $3.50 spent for fertilizer on wheat brings a return of $12 to $15."

Mr. Brand suggested that "cooperative demonstrations in the use of chemical plant food be staged in the 48 states on each of the three to five most important crops grown in each agricultural county, such demonstrations to be carried out on a scale sufficient to commend them to the farmer as thoroughly practical and undoubtedly reliable."

He also suggested for consideration the employment of more extension specialists "to carry to the farmer immediately, through the county agent and

vocational training systems, the farm bureaus, granges, unions and other available instrumentalities, the results obtained from fertilizer and other soil-fertility research."

CREATING THE DESIRE TO WORK

THERE is developing, just at this time, considerable criticism of existing immigration laws. Advocates of unrestricted admission of aliens are beginning to make themselves heard again, with the result that all who have the best interests of the country at heart need to be aggressively condemnatory of any such influence.

To the argument for more men (with the background of immigration law repeal) there are many answers. The one safe, and irrefutable answer, is, however, machines. American industry does not need more untrained and almost untrainable aliens to do its work. It needs, rather, to employ machines for the work at hand, and limit its personnel as far as possible to skilled and semi-skilled labor.

However successful we may become in the elimination of waste power or lost motion, machines of course cannot entirely supplant human labor. There will always be the need for human labor in the fabrication of life's necessities, and this simple fact will not become controvertible through automatization, at least in the present age. However, the need for common labor has steadily decreased during the past fifty years, and will still further decrease as American manufacturers and employers adopt mechanical means and improved methods.

Indeed, machines can be made not only to augment production and lower costs, but to increase the workman's morale and decrease labor turnover. After all—the greatest problem confronting the management of any mill, plant or factory, is that of creating the desire to work. If every management could accomplish that one thing—create the desire to work on the part of their employees—their turnover would be lowered to the irreducible minimum, and a vast amount of money, time and effort could be diverted to more profitable ends.

In considering the creation of the desire for work we find three subconscious elements that affect such desire. These are: ventilation, light and noise. Without proper ventilation, physical endurance is cut down, which condition is reflected on the production sheet. Light is an equally important factor in determining the productivity of human labor. Noise is a third element that subconsciously affects the efficiency of the workman, which of course bears upon his own as well as his company's earning power. The betterment of any one or all of these three elements will do much toward bringing production to its maximum.

Consciously, workmen demand six major things, the absence of any one of which will materially contribute to labor turnover. The six elements are:

1—fair wages—
2—harmonious surroundings—
3—security of position—
4—possibility of advancement—
5—scope for self-expression—
6—inspiring leadership.

It will be seen immediately that machinery can be made to definitely apply to all these factors, save the last.

Supplanting common labor, so far as possible, through the introduction of mechanical means is the most economically advisable step any employer can make, not only for the present but for the future. In times of actual or threatening labor shortage it behooves every employer to take particular pains to create the desire to work on the part of his semi-skilled and skilled labor. Much can be done to this end by the elimination of detrimental elements and the application of machinery and labor-aiding devices. Not only will certain machinery effect ventilation, light and noise, but in almost every case will heighten the first five of the six conscious elements. The sixth—that of inspiring leadership—depends entirely upon the individual. The other five (or eight) remain only on your will.

INTERNAL GOOD WILL VALUABLE YET INEXPENSIVE

RECENTLY the writer of these lines saw a veritable hornet's nest within one of our large nationally known organizations. And the entire trouble could be laid at the doors of the management for not having sold its employees on the necessity for early and late vacations. A considerable number of employees were growling and threatening among themselves to leave after their vacations were completed. This sort of thing creates labor turnover, which is expensive. Without doubt the present arrangement is advantageous to the firm. A little selling effort on the part of the management would have ironed out the difficulty. No offense was intended; merely a matter of business efficiency. It seemed not to have occurred to anyone in charge to look on the human, personal side of the proposition.

Opportunities to create good will lie within every organization—and in abundance. Offering stock to employees, inaugurating profit-sharing plans, and so forth, are some of the "big" things that can be done to help develop good will. But those plans cost money. The little, thoughtful considerations don't cost very much money. And after all, it's the little things that count.

METALLURGICAL LIMESTONE

By Oliver Bowles
Superintendent, New Brunswick Station, Bureau of Mines

Part I

ENORMOUS quantities of limestone are used for metallurgical purposes. Approximately 23 million tons were so used in the United States in 1925 chiefly for smelting iron ores in the blast furnace. Smaller amounts are used in basic open-hearth steel manufacture, and in smelting lead, copper and antimony ores. Most limestone producers have little knowledge of the way in which their stone is used in metallurgy. Maximum tolerances of silica, alumina, sulphur and possibly magnesium, and minimum content of calcium carbonate may be arbitrarily fixed for the guidance of the producer, but aside from these requirements little information is available to producers on the manner in which their stone is used, the office it performs in smelting, or the effects of impurities. More complete knowledge of utilization would enable limestone operators to solve their production problems more intelligently. On the other hand the metallurgist's knowledge of conditions governing limestone production is commonly quite limited. Wider information on the origin, occurrence and physical character of limestones, on quarrying processes, and on methods of separation from impurities would be of undoubted advantage to the furnace operator.

In the following brief discussion covering both utilization and production of metallurgical limestone it is hoped that the problems of the two groups will be coordinated in a way that will be mutually beneficial. The writer desires to acknowledge many helpful suggestions from S. P. Kinney, T. L. Joseph, and C. H. Herty, Jr., metallurgists of the Bureau of Mines.

Distribution and Transportation of Limestone

It is a fortunate circumstance that limestone deposits are widely distributed in the United States. Every state has deposits. On account of lack of the desired chemical or physical properties, or difficulties of quarry operation or rock transportation, large tonnages of metallurgical stone are transported for long distances.

Naturally the widest development has been near the centers of the great smelting industries. Thus the Eastern Ohio and Western Pennsylvania quarries supply enormous quantities of limestone for the smelting districts lying in and about Cleveland, Ashtabula, Youngstown and Pittsburgh. The growth of great iron smelting industries at lake ports, such as Chicago, Cleveland and Buffalo, is due in part to cheap water transportation of the ores from the Lake Superior district, and in part to the same ease in transportation of fluxing stone. The accessibility of the iron ranges to the Great Lakes has its counterpart in a lesser degree in the development of a great limestone industry in the Northern Peninsula of Michigan near Alpena and Calcite, where the largest quarries in the world are now operated, producing thousands of tons of stone every day. It is noteworthy that the low cost of water haulage permits transportation for many hundreds of miles, while rail haulage for similar distances would be economically impossible.

Production Statistics

Following is a list of the chief flux-producing States with their tonnages based on 1925 figures compiled by the Bureau of Mines:

Fluxing Stone Production in Short Tons in the Leading States.

State	Short tons
Pennsylvania	8,465,170
Michigan	6,054,270
Ohio	2,917,380
West Virginia	2,208,220
Alabama	889,840
Illinois	710,130
Colorado	355,060
Utah	207,140
All other states	1,033,290
Total	22,840,500

Purpose and Action of Furnace Flux

Most iron ores carry silica and alumina as impurities, and the addition of a basic flux such as limestone is necessary to form a slag with them.

Lime is infusible at the temperature of a blast furnace, but when it combines with the silica and alumina of the ore and the ash of the coke it forms a liquid slag which floats on the molten iron. Thus the molten iron, freed in large measure of these impurities, is tapped off from beneath while the slag is drawn off separately and removed to the slag dump.

Another purpose of the flux is to remove the sulphur from the charge, for this element is a serious impurity in iron and steel. Thus an important function of fluxes is to provide materials that have greater affinity for such an impurity than the impurity has for the iron, steel or other metals. Normally the slag removes about 85 per cent of the sulphur entering the furnace.

Lime is regarded as a better desulphurizing agent than magnesia. Lime has a greater affinity for silica than it has for sulphur, hence it forms calcium silicates until the silica is exhausted, after which it reacts with the sulphur to form calcium sulphide. It is important, therefore, to have present an excess of lime above that required to combine with the silica. For the most effective reaction a high temperature should be maintained, for at high temperatures the slag will more completely desulphurize iron than at low temperatures. This is due to increased rates of interchange between slag and metal at the higher temperature, and to the fact that a more basic slag can be carried. Sulphur and other impurities are best removed where the slag has a high fluidity.

Some ores are associated with sufficient lime to be self-fluxing. Ores are said to be self-fluxing when the sum of the calcium and magnesium oxides is approximately equal to the sum of the silica and alumina. Such ores occur in the iron district of Birmingham, Alabama. They smelt very readily as the constituents are intimately mixed.

Effect of Impurities on Fluxing Stone

The majority of blast furnaces employ about 900 pounds of flux for each long ton of pig iron produced. The amount of flux required varies with the amount and nature of the impurities in the ore and in the stone itself. The foreign elements in fluxing stone are usually the same as those in the ore for the removal of which the flux is added, namely, silica and alumina. It should be emphasized that impurities in the limestone are doubly detrimental; in the first place their presence reduces the percentage of lime and magnesia in the stone, and in the second place they require a certain share of the lime and magnesia to flux them off, as the flux must neutralize its own impurities as well as those of the ore.

"Available carbonate" is a term applied to the percentage of calcium and magnesium carbonates available for fluxing the ore after a sufficient percentage has been deducted to neutralize the impurities in the stone itself. In the average blast-furnace slag the ratio of $SiO_2 + Al_2O_3$ to $CaO + MgO$ is about 1 to 1. Thus for every pound of silica and alumina present in a high calcium flux, a pound of lime is required to flux it. A pound of lime (CaO) is derived from 1.785 pounds of limestone ($CaCO_3$). Hence if there are 4 pounds of $SiO_2 + Al_2O_3$ in each 100 pounds of the stone, not only does the stone lose this 4 pounds of impurity, but also 4×1.785 pounds of pure limestone which are required to flux the impurity, that is a total of 11.14 pounds, and the "available" carbonate in each hundred pounds of stone is only 88.86 pounds. This may be expressed in a general formula as follows: If A = the percentage of $SiO_2 + Al_2O_3$ in the stone, then the available carbonate is 100 — A 1.785A, or 100 — 2.785A. Where a dolomite is employed it requires about 1.914 pounds of stone to give one pound of the combined oxides of calcium and magnesium. Hence for a dolomite flux the general formula for determination of available carbonate becomes 100 — 2.914 A. Most fluxing stone used in the United States runs under 10 per cent magnesium carbonate, and hence the conversion factor may be taken as 1.8 and the general formula 100 — 2.8A.

The presence of impurities has other disadvantages. It has been noted above that a certain percentage of the oxides liberated from the carbonates in the stone unites with the silica and alumina in the stone to form a slag. It is evident that the fluxing of these materials will require fuel; therefore, the fluxing of the impurities in the stone requires additional coke above that required for fluxing the silica and alumina in the ore. Extra slag requires extra coke but there is a difference of opinion as to how much extra coke is needed. As other conditions may affect the amount of coke required for each additional pound of slag formed, it is difficult to arrive at an actual figure for the additional fuel cost when an impure stone is used. If A = the sum of silica and alumina in the stone, the slag formed from these impurities will be approximately 2A. If it is assumed that "x" pounds of coke are required for each pound of slag, then the extra coke required to flux the impurities in the stone will be 2Ax pounds for each hundred pounds of stone. Hence, any blast-furnace operator who has determined a figure for the amount of coke required for each additional pound of slag formed, can estimate closely the additional fuel expense due to the use of impure stone. Assuming a value of y cents per ton for metallurgical coke, the extra cost of fuel on account of impurities in the stone will be $\frac{2Axy}{2000}$ or $\frac{Axy}{1000}$ cents for each 100 pounds of stone. For each ton of stone this will be $\frac{20Axy}{1000}$ or $\frac{Axy}{50}$ cents.

A third source of loss due to impurities in the stone is reduced furnace output. Furnace output for a given ore is in general inversely proportional to coke consumption per unit of slag, and as the extra slag requires extra coke furnace production is cut down to some extent.

If V = the price in cents of pure stone per ton, and V^1 = the price of impure stone, then, disregarding the possible reduction in furnace output and combining the two chief sources of loss, namely the reduction in available carbonate and the extra fuel required, $V^1 = V(1 - .028A) - \frac{Axy}{50}$. By

substituting any given values for percentages of impurities, pounds of coke per pound of slag, and value of coke per ton, a fairly definite figure may be obtained for the value of an impure stone as compared with a pure stone. If the value of an impure stone as thus calculated is lower than the actual cost at which such stone may be delivered at the furnace, it would not pay to use the impure stone.

Other impurities in the stone are sulphur and phosphorus. Usually they are present in amounts so small as to be negligible. A sulphur content of less than 0.1 per cent does no harm, and it is unusual to find more than this amount in commercial limestone. Phosphorus is usually deleterious only where the flux is used in the manufacture of Bessemer iron. Where so used the phosphorus content should be as low as possible, and should not exceed 0.01 per cent. For other grades of iron the phosphorus content may reach 0.1 per cent without harmful results, and a content as high as this is exceedingly rare.

The effect of magnesia in fluxing stone is an unsettled question. Some furnace men are opposed to magnesium while others use magnesian stone successfully. Dolomite is widely used as a blast furnace flux in England. As a rule high-calcium fluxes are preferred if they are readily attainable, but the difference in action between the high-calcium and the dolomitic fluxes is so small that usually the choice is governed by other factors such as cost of percentage of impurities. For example, at some of the Alabama furnaces dolomite is preferred, not because of any preference for magnesia but because the dolomite has a lower silica content (1.25 per cent as against 3.5 per cent in the high calcium stone) and also because of a greater uniformity in the composition of the dolomite. The subject of magnesia is discussed more fully in a subsequent section.

Use of Impure Fluxing Stone

The cost of stone delivered at the furnace commonly has a very direct bearing on the quality of stone used. This is due to the fact that an inferior stone may be used if the price is low enough. The question of quality is so intimately related to cost that the problem of purity of blast-furnace flux becomes quite complex. In order to clarify this point, it is necessary to make a distinction between impurities. In general they fall in two classes. Some, such as sulphur and phosphorus, are detrimental to the quality of the iron produced, hence the use of stone containing excessive quantities of these impurities could not be justified no matter how low the price. The other more common and abundant impurities are silica and alumina, and they are not regarded as detrimental to the iron, their chief disadvantages, as pointed out previously, being the requirement of additional limestone and coke to convert them into slag. Suppose that a relatively pure stone and an impure stone are both available, and that the impurities are of the silica-alumina type which has no detrimental effect on the iron. If the price of the impure stone is low enough to overcome the disadvantages then the impure stone may be used in preference to the pure stone. Thus at Bethlehem, Pa., a stone quarried near the furnaces, running as high as 5 per cent silica is used extensively in preference to the low-silica stone from McAfee, N. J., because the transportation charge from McAfee is greater than the total cost of quarrying the impure stone. The quality of the ore also influences the degree of impurity permissible in the flux. Thus it would not be wise to use a flux high in silica with a high silica ore.

It is evident from the above that no definite rules can be laid down regarding the purity of a stone that may be used for flux. A stone that might be condemned in one locality, might be quite acceptable in another where the conditions were different. The direct bearing of cost on use indicates how important it is to be able to calculate even approximately the relation between percentage of impurities and price, as discussed previously. Usually the use of an impure stone can be justified only where it has the advantage of close proximity to the furnace, thus eliminating the usually heavy item of transportation expense.

Size of Stone for Blast Furnace Flux

Fluxing stone is used in a great variety of sizes. At some furnaces the crusher run is used directly without screening. Usually the fines below ½ inch are taken out, partly because they tend to retard the draft, and partly because they usually contain more impurity than the lump stone, as sand and clay segregate in the fines. In modern quarry practice, and particularly in underground mining there is less impurity mixed with the stone than during former years under cruder practice; therefore, on the basis of purity, fine materials may not be detrimental. A common range in size is $-4\frac{1}{2}$ inch, $+\frac{1}{2}$ inch, though larger sizes are often used. Maccoun[1] claims that all stone should pass through a 6-inch ring, as larger lumps may go unburned even to the tuyere, wasting heat, and injuring the furnace lining by corrosion. Blast-furnace troubles have been attributed in some instances to irregularities in size of the limestone used. In general it may be stated that uniform sizing improves the working of the furnace.

Basic Open-Hearth Flux

The open-hearth process of making steel consists in melting pig iron and steel or iron scrap, and boil-

[1] Maccoun, A. E., "Recent Blast Furnace Advancement," Blast Furnace and Steel Plant, vol. 49, 1915, p. 67.

ing the mixture generally with the addition of some very pure lump iron ore, until the carbon is reduced to the desired amount. A flux is added to the charge in the furnace mainly for the removal of phosphorus. For a phosphorus content in pig iron not exceeding 0.25 per cent, additions of 6 to 12 per cent limestone are considered good practice. When a pig iron with a higher phosphorus content is used as much as 17 per cent limestone may be charged. The phosphorus is oxidized to phosphoric acid which unites with the lime to form calcium phosphate. The ability of a slag to take up phosphorus depends both on basicity and fluidity. Fluorspar (CaF_2) is added because it increases the fluidity without decreasing the basicity. It is possible, however, to have the slag too fluid, for it then becomes active in attacking the dolomite lining. The more basic the slag the higher its melting point; hence, the higher its temperature the more lime it can absorb. An excessively high temperature is also destructive to a dolomite lining as it may approach the softening point of the dolomite.

Either lime or limestone may be used. When the flux is added in carbonate form the evolution of CO_2 makes the bath boil, insuring a lively reaction. Extra heat is required for calcination, but evidently no more additional heat is needed than would be required for precalcination.

In blast-furnace slag the proportion of $CaO + MgO$ to $SiO_2 + Al_2O_3$ is about 1 to 1, but with basic open-hearth slag this ratio is about 2.5 to 1. Hence if A equals the sum of SiO_2 and Al_2O_3 in the fluxing stone, the bases ($CaO + MgO$) necessary to form a slag with these impurities will be 2.5 A, and the carbonates required will be $1.8 \times 2.5A$. The formula for determination of available carbonate is therefore $100 - (1.8 \times 2.5A + A)$, or $100 - 5.5A$. In comparing this with the general formula for available carbonate in blast-furnace flux which reads $100 - 2.8A$, it is evident that impurities are much more detrimental in open-hearth than in blast-furnace flux. Thus a limestone with 2 per cent impurity when used as blast-furnace flux would have an available carbonate content of 94.4 per cent, while if used for basic open-hearth flux it would have only 89.0 per cent available carbonate. On this account specifications for open-hearth flux usually demand a limestone with a silica content not to exceed 1 per cent, and an alumina content not exceeding 1.5 per cent.

As the chief office of basic open-hearth flux is the removal of phosphorus, and as magnesium has a lower affinity than calcium for this element, dolomites or magnesian limestones are undesirable. The maximum permissible content of MgO is usually fixed at 5 per cent. Where the blast furnace is operated in connection with a steel plant the open-hearth slag may be used as blast-furnace flux, for it provides both iron and flux. It may be used up to 10 per cent of the total ore burden.

The size of stone to be used in open-hearth steel furnaces depends to some extent on the rate of solution of the stone in the slag. Fragments of most well-consolidated limestones retain their original shapes, and are more or less firm and solid after complete calcination. Lime burners desire stone of this quality, for it gives a high percentage of lump lime. Therefore, after the limestone lumps in an open-hearth furnace are completely calcined, they may still retain their original shapes. Limestones vary greatly in the rate at which such masses of lime dissolve in the furnace charge, and obviously large masses of a slow-dissolving stone should not be used. No definite data have ever been assembled on the rate of solubility of various limestones in the open-hearth furnace.

It is noteworthy, therefore, that the adaptability of a stone for open-hearth flux depends on the rate of solution as well as on composition. A slow-dissolving stone may demand an unusually long time for the complete reaction to take place in the charge. Sometimes excessive fluorspar is added in an attempt to hasten the reaction, and this has the double disadvantage of wasting comparatively high-priced fluorspar, and of making the slag too liquid.

Use of Dolomite as Furnace Lining

Magnesite ($MgCO_3$), dolomite ($CaCO_3 . MgCO_3$), and dolomitic limestone are used for lining basic open-hearth furnaces. Dolomite is the most common. Usually it is precalcined before it is placed in the furnace. The dolomite should be low in impurities, for if impure lining is employed its softening temperature is lowered and it is more easily attacked by a fluid slag. The raw material is crushed, calcined, mixed with a small amount of tar or molasses, and tamped in to a depth of 1 or 2 feet over a basic lining of fire brick. The essential requirements of a good lining are (1) refractoriness, (2) resistance to corrosion of slag or metal, (3) absence of disintegration on cooling, (4) absence of cracking on heating, (5) mechanical strength to resist molten flux, (6) low cost. For (1) and (2) there must be low percentages of silica and alumina. For (3) the magnesia content must be high. Dolomite is used in preference to magnesite on account of its much lower cost. The approximate composition of a satisfactory furnace lining is SiO_2 less than 1 per cent, Al_2O_3 and Fe_2O_3 together less than 1.5 per cent, $MgCO_3$ at least 35 per cent, the remainder consisting of $CaCO_3$. Dolomite is used for patching the slag lines where scorification of the hearth is heaviest. It may be used in the uncalcined form.

[In the second and last part of this article, which will be published in the next issue, Mr. Bowles will discuss the production problems involved.]

SAND, GRAVEL AND CRUSHED STONE PRODUCED ECONOMICALLY BY SAME CONCERN

By F. A. Westbrook

THE Pompton Crushed Stone Company, Pompton, New Jersey, operates a gneiss granite quarry which is both well equipped and well operated. The fact that "everything is going fine," as is shown in one of the illustrations where Mr. Snover, foreman, and Mr. Herman Norman, engineer, are standing under a tree with a look of contentment, is of marked significance. Probably the best way to give an impression of this plant is to follow the various operations from the beginning.

The quarry is located on the side of a small mountain, so that hoisting is not necessary. The breast varies from about 100 feet to 120 feet in height. A Cyclone well drill is used for the big holes, eight or ten holes being shot at one time, and six Ingersoll-Rand jack hammers are in service for block drilling. As this quarry is in a sparsely settled region there is no trouble from large blasts; so the holes are drilled from the top of the breast to a point about 5 feet below the floor of the quarry. The drilled holes are 8 inches in diameter, 25 feet back from the face and 25 feet apart and about 1500 pounds of dynamite is used in each hole. When blasting, the first 25 feet is charged with 75 per cent Du Pont gelatine dynamite, up to about 30 feet from the surface with 60 per cent dynamite, and tamping fills the upper 30 feet. Cordeau is used to set off the charges.

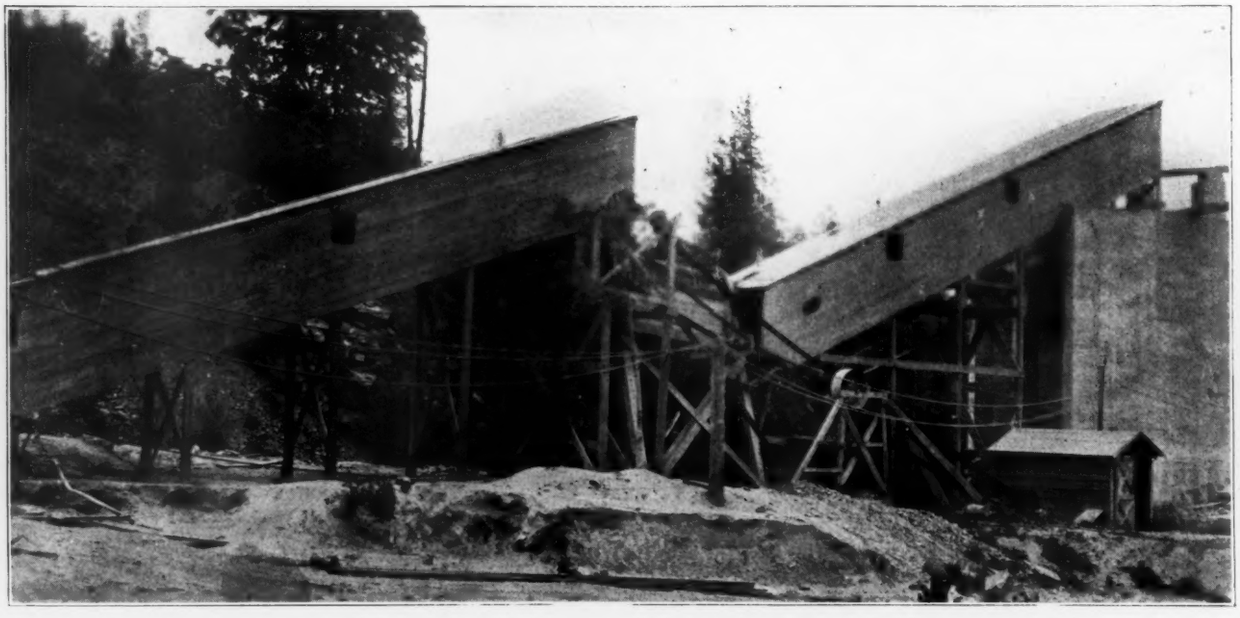
"Everything Going Fine." D. Snover, foreman (left), and H. Norman, engineer

A Thew steam shovel picks up the stone at the working face. It is equipped with an American Manganese Steel Company dipper and its door has been provided with a manganese steel plate to take the abrasive wear which occurs when the stone is discharged. Formerly some trouble was experienced, due to the hardness of the rock, by the plate wearing, but the manganese steel plate has re-

Sizing Screen House and Loading Bins. Railroad Siding at Right

At the Working Face of the Quarry, Showing Height of Breast

Bins and Screen Mounted on Locomotive Tender Truck

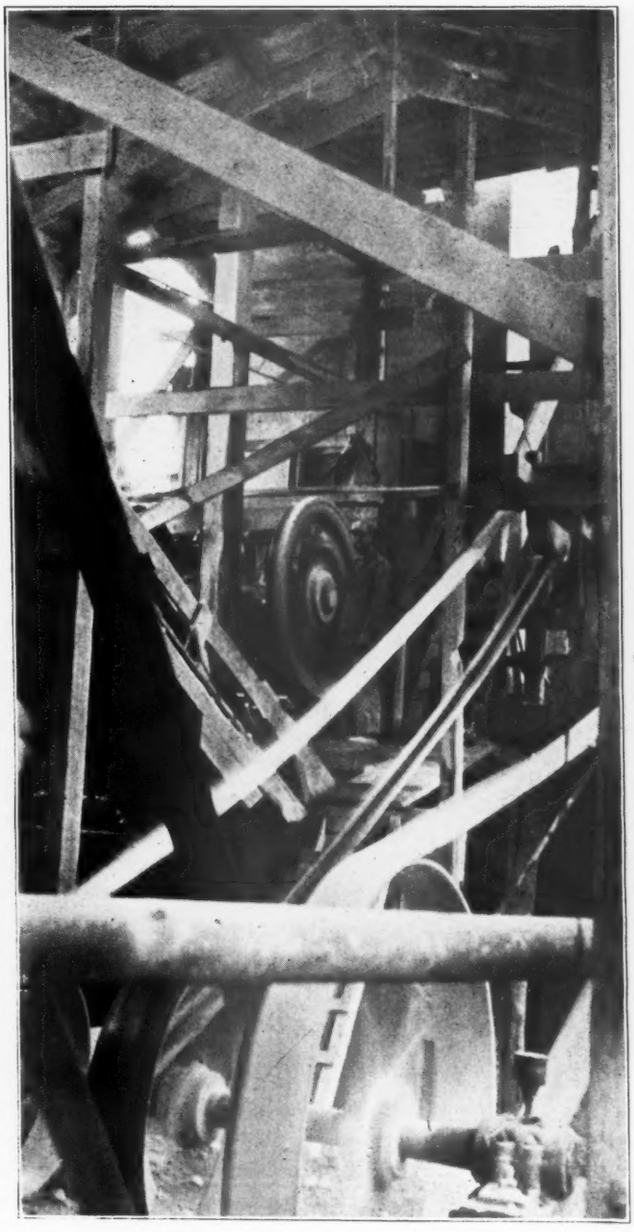


Conveyor from Primary Crusher to Scalping Screen and from Latter to Oversize Storage Bin

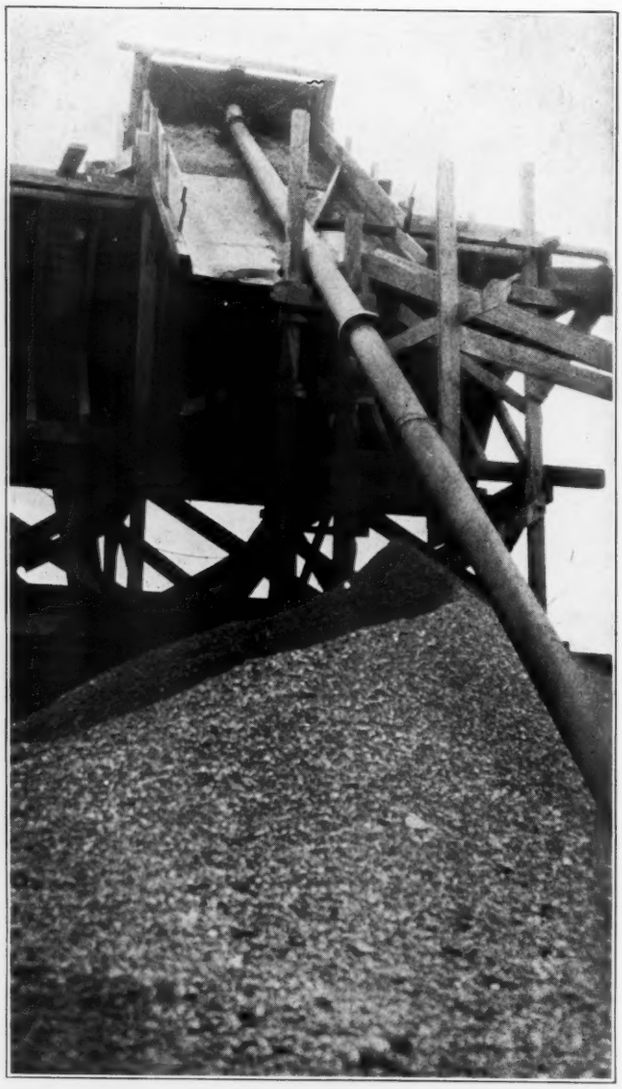
Steam Shovel and Truck at the Working Face

moved this difficulty. The stone is loaded into two trucks, one a Mack with a Wood hoist and the other a White with an underslung hoist. These trucks transport the stone across the floor of the quarry to the 30 by 36 inch Farrell primary jaw crusher. This is driven by a 250 h.p. General Electric induction motor which replaced one of 150 h.p., which, under certain conditions, had not sufficient power. This does not mean that such a large motor should always be used for this size of crusher, as it often depends on the hardness of the rock or the way in which the material is fed to the crusher.

A really ingenious idea has been carried out in lining the bottom of the chute into which the trucks dump the stone and which leads to the primary crusher. Trouble was formerly caused with this detail because the plates which were being used wore out or broke, but about three years ago a number of old jaw plates from the crushers were collected and these used to line the bottom of the chute. Since then no trouble has occurred with these plates. As Mr. Snover, the foreman, remarked, "These jaw plates wear the best of anything we have ever tried." Before proceeding fur-



Lower—View of Boat and Pipe Line. Upper Right—An Interior View of the Power Plant

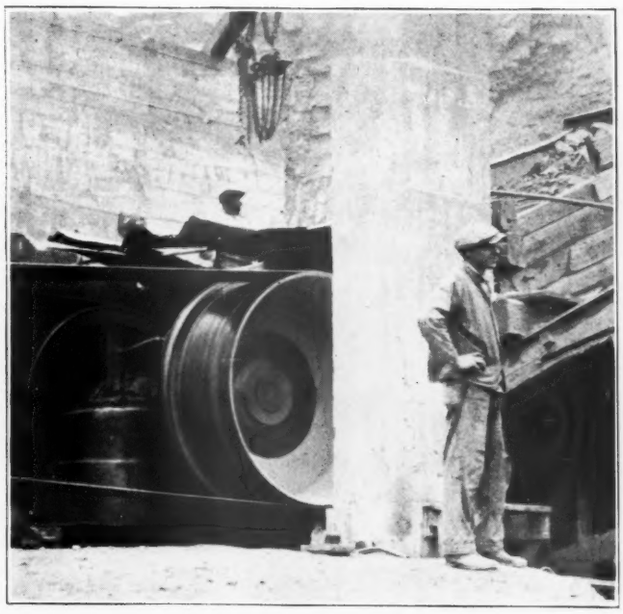


Upper Left—The Tertiary Crusher. Upper Right—Pipe Line to Top of Stationary Inclined Screen.
Below—Block Holing After Blast

ther it should be said that this plant is an Earl C. Bacon installation, so far as machinery and design are concerned, that Manhattan belts are used exclusively for both transmission and conveying and that the conveyor idlers are Robins manufacture.

From the primary crusher the stone is taken on an inclined belt conveyor, 30 inches wide and about 75 feet between centers, to the scalping screen. The throughs from this screen drop on a 20 inch belt which discharges into another belt leading from the secondary crushers to the sizing screen. Oversizes from the scalping screen discharge to another inclined belt, 30 inches wide and about 75 feet between centers, which deposits them in concrete storage bins. These conveyors and the scalping screen are driven by a 45 h.p. Western Electric motor provided with a Western Electric control. At the bottom of the concrete storage bins there is a chute leading to a 30 by 13 inch Farrel secondary crusher and from this the material is taken on an inclined 30 inch belt conveyor, about 64 feet between centers, to the sizing screen. Oversizes from this screen are returned to a 20 by 7 inch Farrell tertiary crusher, which is located alongside of the secondary crusher. The width of this latter conveyor belt is 20 inches and the length about 64 feet. The tertiary crusher discharges into the same 30 inch conveyor used to carry the rock from the secondary crusher to the sizing screen. All of this machinery is driven by a 150 h.p. General Electric motor.

A series of bins have been provided under the sizing screen from which trucks may be loaded as well as railroad freight cars. Stock storage



The Primary Crusher

Dumping a Load of Quarry Stone into the Primary Crusher

Scalping Screen and Conveyor to Concrete Oversize Storage Bin

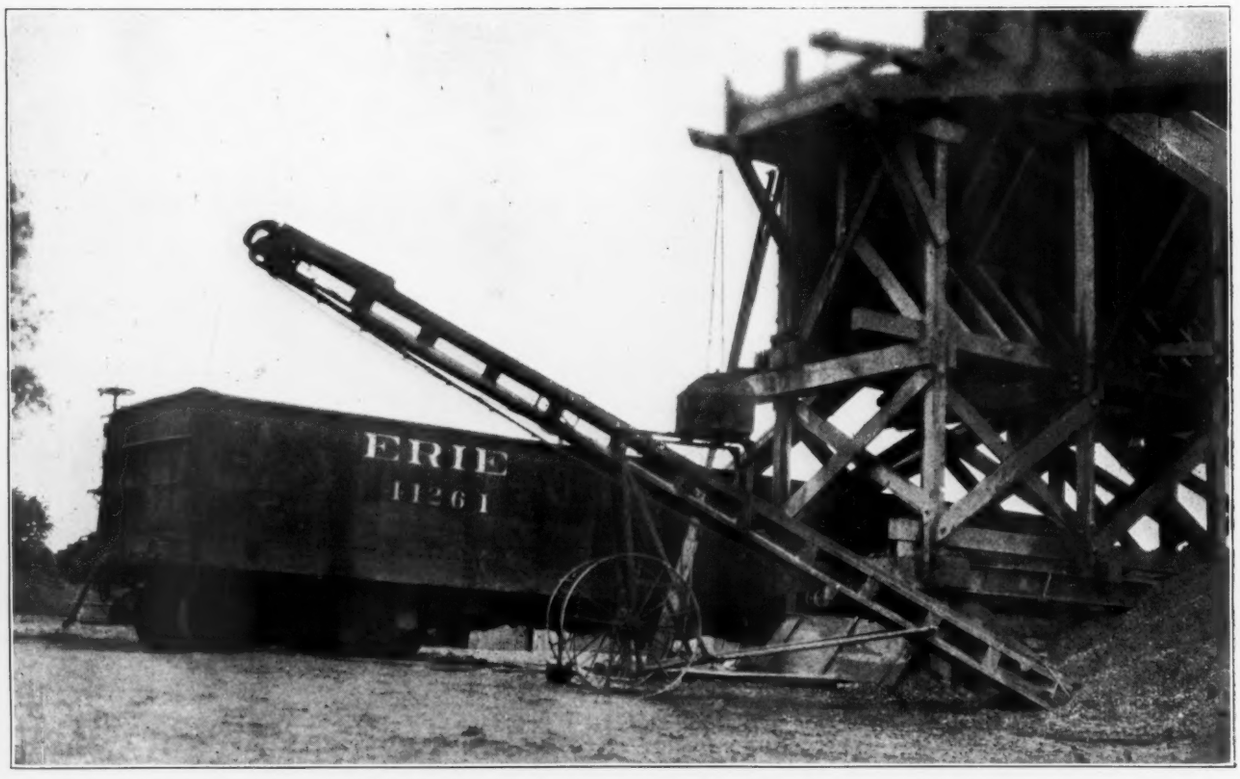
Freight Car Loading with Sand from Bins

Loading a Truck from Stock Storage

piles are made in three places on the property which are used as material accumulates during the slack months but by early summer the piles become very much depleted. The piles are made by dumping truck loads of material off a bank, wherever practicable, and extending them by backing the trucks over the tops of the piles. Pieces of old screens are put down on the road to keep the wheels of the trucks from sinking into the road surface. A Vergan-Schmidt Company tractor crane with a 32 foot boom, built on a Deering Harvester Company truck, is used for loading the trucks. This crane was purchased through the Wilson Equipment Company.

The plant has, of course, considerable other equipment. This includes an Ingersoll-Rand Imperial, type 10, compressor of 600 cubic feet capacity driven by a 100 h.p. General Electric motor; a Leyner drill sharpener in the forge shop and a Buffalo hand forge blower for use when the compressor is shut down. At the office building, adjacent to the truck loading bins, is a W. S. Meyer scale. Originally this plant, which has been in operation for years, was steam driven but electrification was completed two years ago. The old boiler room is now used for the electrical service entrance and also for the storage supplies.

This company also produces sand and gravel under the name of the Pompton Sand and Gravel Company and this operation is well worth noting. "We turn out 250 yards of sand and gravel with



Portable Belt Loader Used for Loading Gravel from Stock Pile on Freight Cars or Trucks

two men in addition to myself," said the superintendent. "There is one man at the pump and another at the screen and I help out wherever it is necessary," he continued.

Such a record is certainly sufficient to arouse one's curiosity and is an example of the axiom that the interest centering in a plant does not necessarily lie in the amount of its production. This operation cannot be classed as a large one, in comparison to many others, and yet I have seen many employing from eight to fifteen men which produced only half as much material. For instance on the Saturday morning of my visit three freight carloads of sand had been shipped by noon in addition to 30 yards of sand and 12 yards of gravel by contractors' trucks. Normally seven or eight carloads plus numerous truck loads are shipped each full working day. This plant has the distinction of shutting down Saturday afternoons, running somewhat longer on the other days of the week to make up for this half day. It thus has the advantage of being able to supply contractors with material late in the day so that this material will be in readiness for use the next morning. Saturday afternoons are not so important from this viewpoint, as a general thing, because the contractors are more interested in finishing up the week's work promptly if they do operate on Saturday.

The conditions of this deposit are favorable in that the bed consists only of sand and small gravel; there are no cobbles or boulders. However, the bed is wooded and the old roots form some obstruction but nothing very serious. The property covers approximately 52 acres. The hydraulic equipment is of the simplest kind and consists of an 8 inch Morris pump driven by a 75 h.p. General Electric induction motor, and suction is employed in removing the material. A 20 h.p. boiler is used to prime the pump and to operate the small hoist for raising and lowering the section pipe, and the pond is pumped to a depth of 35 feet. At the higher levels the materials are pumped out from around the roots, which, together with their stumps, are allowed to sink to the bottom of the pond. This naturally retards operations somewhat but is good practice under the conditions existing here on account of its simplicity.

An 8 inch pipe line provided with a 5 inch gate valve conveys the sand from the boat to the screening plant. This pipe has been in service for several years and shows no signs of wear. It was purchased second hand and has proved as satisfactory as the other equipment, most of it having been purchased second hand. In fact, the comparatively small investment in equipment is one of the strikingly interesting features of the operation. It shows what can be done by good judgment and careful planning of expenditures and the plant arrangement is really a creditable piece of engineering practice.

The material is pumped to the top of an inclined wire mesh stationary screen. The sand and water pass through this screen into bins from which there is an overflow trough and the gravel slips off the screen to an outside pile. The sand is unloaded through chutes into freight cars on trucks and the gravel is loaded by means of a Passaic Portable Machine Company's electrically operated portable belt loader. No particular effort is made to make storage piles. The hydraulic apparatus operates as the freight cars are being loaded and under good conditions a 36 yard car can be loaded in 40 minutes. Of course, there may be accumulations of gravel if the demand is decidedly slack, but there is ample space for this material. The company does no trucking itself, the contractors sending their own trucks for such material as they want, and the remainder is shipped by rail. This is conveniently accomplished as the plant is adjacent to the Greenwood Lake Division of the Erie Railroad and cars may be run alongside the bins.

Another interesting feature of this plant is that the screen and bins have been built on an old locomotive tender which sets on tracks. In this manner it is easy to move the entire structure along the shore of the pond and avoid unduly sharp curves or excessive length of pipe line when the position of the boat is changed.

More American Money Going Abroad

American concerns and citizens now are sending their money abroad for investment in the securities of foreign governments at the rate of $83,219,000 monthly. Last year the rate of such investment was $42,844,000 monthly while in 1925 it was $53,782,000. Investments in the securities of foreign private concerns and corporations are also large this year.

If the present rate of investment continues throughout the year the value of the securities of foreign governments alone sold here this year will be close to one billion dollars. This, however, is hardly to be expected. During the first four months of 1927, foreign governments sold approximately $332,876,000 worth of their obligations in the United States. These were taken entirely by private investors.

Foreign governments now owe the United States Government in the neighborhood of twelve billions of dollars as a result of funded war loans. The United States Government is no longer making such loans but private citizens are making loans abroad at a rate that will soon make them creditors in sums nearly equal to those of the federal government.

ASPHALT PAVING MIXTURES THEORY AND PRACTICE

By A. W. Dow
Dow and Smith, Consulting Engineers*

SINCE the early days of asphalt paving many attempts have been made to devise methods by which the formula for a sheet asphalt mixture could be predetermined in the laboratory, but up to the present it has not been done and until certain fundamental principles relating to the interfacial surface tension between solids and liquids have been more thoroughly studied it will not be possible. I hope to give you in this paper a brief statement of what has so far been accomplished and discuss some of the fundamental principles that are still insufficiently understood.

In the early nineties the laboratory of the Barber Asphalt Paving Company did considerable research work for the purpose of establishing a general formula that might be used as a guide for the manufacture of good sheet asphalt mixtures. At that time Mr. H. C. Bowen was chief chemist and the writer his principal assistant. From a study of the analysis of pavements that had done exceptionally well and of paving mixtures that worked satisfactorily Mr. Bowen suggested a formula for an ideal aggregate. The composition of this aggregate as published by me in my first report as inspector of asphalt and cements for the District of Columbia for the fiscal year ending June 30th, 1894, is as follows:

	Per Cent
Passing 10 mesh retained on 20.....	10.0
Passing 20 mesh retained on 40.....	30.0
Passing 40 mesh retained on 60.....	15.0
Passing 60 mesh retained on 80.....	12.0
Passing 80 mesh retained on 100.....	10.0
Passing 100 mesh.....	23.0
	100.0

While the screens used in those days were not the same as are now in general use and the 200 mesh screen was yet unknown, you can readily see that this is in accord with what is now considered a good paving aggregate, 10% passing the 80 mesh and a total of 23% passing the 100 and 200 mesh.

At that time we did not feel justified in stating a definite percentage of bitumen or even giving a method by which it could be approximated other than by trial. We believed the surface area and voids in the aggregate were the governing factors and while we worked out a method for determining voids and a great deal of work was done on this, no conclusions were arrived at owing to the fact that actual practice did not appear to justify some of the theoretical deductions. For a long time we believed this was due to the inaccuracy of our method for determining the voids, but it seemed impossible to devise a means by which the sand could be kept from segregating while being run into the void determining receptacle. For these determinations we first used a glass graduate but finally adopted the use of a heavy glass bottle with gradually sloping sides having a capacity of about 400 cc. A bottle of this shape is about equivalent to the metal cone receptacles that have been in use for some years past. It has the advantage in being transparent so that you can readily see how badly the sand segregates. The method consisted of slowly running the sand in the bottle and at the same time shaking and jarring it until the volume of the sand ceased to diminish.

Possibly if recent experimenters on the void theory of sheet asphalt mixtures had used glass in place of iron vessels with which to make this determination they would have had less faith in their results and might have done some work on improving the method which is surely greatly needed. While this method for determining voids in the mineral aggregate has been in use up to the present the results have never been considered as anything more than an approximation and the writer has been suspicious for some time that the voids thus obtained were greater than those actually in the paving mixture and occupied by the asphalt cement. That this is most likely the case has been brought out by Messrs. Hubbard and Field in their paper read this year before the American Society for Testing Materials. They show that there is good reason to believe that in some cases at least the asphalt film between the sand grains is thinner than the air film surrounding these same sand grains in a dry condition.

Void determinations on mineral aggregates and their relations to the design of sheet asphalt paving mixtures was most thoroughly investigated in the laboratory of the Barber Asphalt Paving Company under Mr. Richardson and the results published in his book "The Modern Asphalt Pavement." He showed that, by adding filler in increasing amounts to a sand, the voids diminished until the filler reached a certain per cent (41.7%) and that after that the voids started to increase. Mr. W. S. Wilkinson of the Asphalt Block Industry also did considerable work on voids in mineral aggregates but found that by mixing the limestone

*Presented before the 1926 annual convention of the American Society for Municipal Improvements.

dust with the asphalt cement before it was added to the mixture he could diminish the quantity of bitumen, but more will be said of this later.

My first report as inspector of asphalt and cements mentioned above is also interesting because it is the first published discussion on the desirability of using graded sand and the necessity of having the voids between the larger grains filled with smaller grains, thus producing a mixture with very small voids.

In a paper read by me before the Washington meeting of the American Society for Municipal Improvements in 1898 I still further discuss sheet asphalt mixtures and point out that aggregates with small size voids made more stable mixtures, thus allowing the use of softer asphalt cement, and in this paper it will also be noted that for the first time mention is made of the difference in the stability of mixtures due to the surface conditions of the sand grains, smooth grained sands making less stable mixtures than through grained sands.

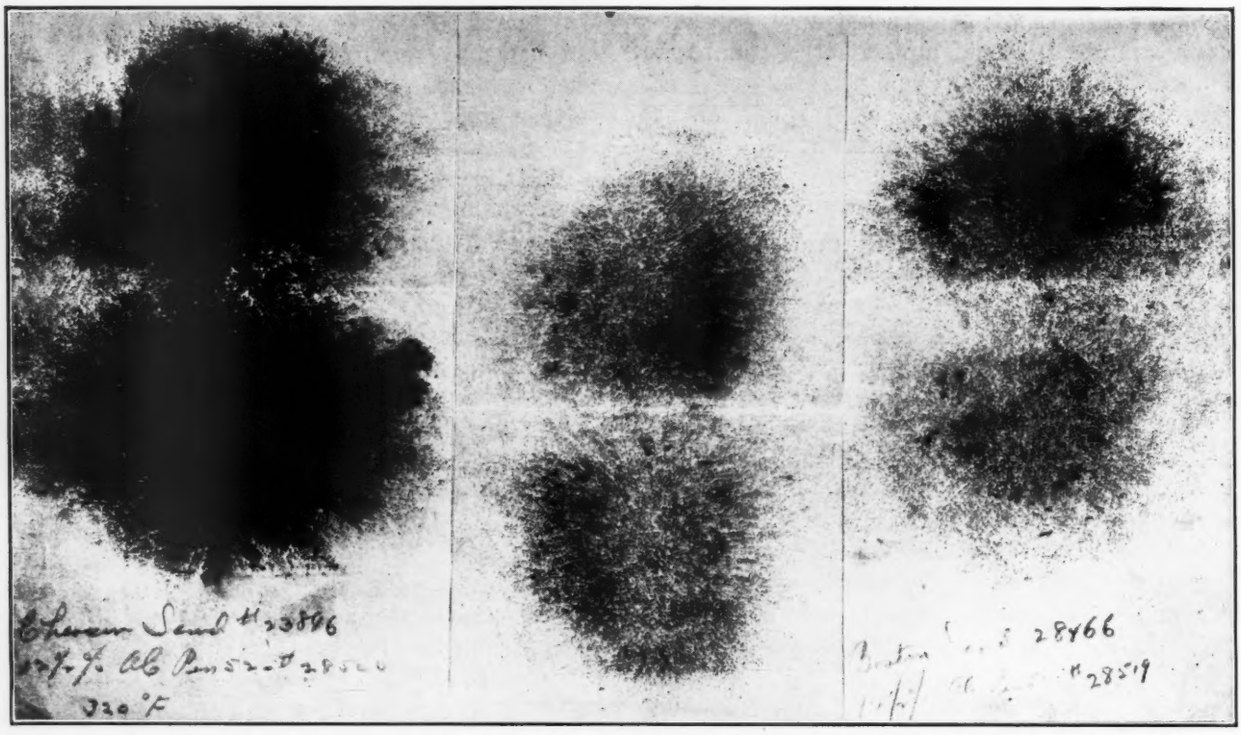
In 1905 Mr. Richardson published the first edition of his book on The Modern Asphalt Pavement, which is an account of the research work carried on by the laboratory of the Barber Asphalt Paving Company up to that date. The chapters on mineral aggregate and on surface mixtures are most instructive and should be carefully studied by every one who is at all ambitious to devise new types of mixture. Mr. Richardson for the first time points out one of the most important factors in the designing of sheet asphalt mixtures and, strange to say, the one that has received the least attention. This factor is the property of asphalt cements to coat or wet some mineral surfaces better than others. He cites the case of two sands of practically the same mesh composition and percentage of voids where one required 2% more asphalt cement than the other to make equally rich mixtures. In his chapter on surface mixtures he says: "It has become very evident from what has been said in the preceding pages that the amount of bitumen or asphalt cement in any mixture is very variable depending on the grading of the mineral aggregate and upon the peculiar surface of the sand grains. * * * The proper amount of bitumen may vary from 9 to over 14%." On page 349 he calls attention to some determinations made by the Bureau of Soils on the thickness of absorbed aqueous films on different minerals where they found the following values:

Silica	167.00×10^{-6} cm.
Glass	18.00×10^{-6} cm.
Quartz	$.45 \times 10^{-6}$ cm.

He believes that these data make it possible to conceive of a sand made up of particles which may vary as largely in the thickness of the film of asphalt cement required to coat them as do the minerals experimented with above. This may explain why one sand with the same grading and voids as another may require different percentages of asphalt cement. Any one that has been at all observant must have noted on examining some surface mixtures under a microscope that some grains of sand are more heavily coated with asphalt cement than others. In fact some are coated so thinly that the coating is hardly visible.

There are numerous examples that can be given to illustrate this selective action of solid surfaces with liquids.* As for instance copper prefers kerosene to water, quartz prefers water to kerosene, sulphide ore prefers oil to water while the gangue associated with it prefers water to oil. Upon these properties is based the well known flotation process for the concentration of sulphide ores. It is a known fact that the asphalt films on most sands are readily replaceable under certain conditions by water containing a small quantity of soap or soda, hence the disintegration of asphalt gutters in which soapy water is allowed to run. This is also the principle of Walczak and Rice's method for recovering the bitumen from mineral aggregates. In none of these cases is the asphalt dissolved. The separation depends upon the fact that the mineral grains have a greater adsorptive property for the one liquid than for another and the asphalt film is replaced by the water containing either soap or soda. There has been a great deal of interesting work done by the Bureau of Soils on the absorption of solids from solutions by different soils. In their bulletin No. 52 by Patten and Waggaman is a most interesting treatise on the work that has been accomplished along these lines. They mention the absorption of different dyes by quartz powder and other mineral constituents of soil. I myself have done some work on the relative absorptive value of different mineral powders for asphalt cement by shaking the powdered mineral in a 0.05% solution of asphalt cement in carbon disulphide and noting the degree of decolorization that takes place. Some clay soils absorb as high as 98% of the asphalt cement from the solution; powdered quartz only about 15%; limestone with high percentages of carbonate of lime about 40%; cement rock composed of limestone and shale about 60%. This absorption is not entirely dependent on the fineness of the mineral particles as some seem to believe, for I have recently examined a dust over 94% of which passes a 200 mesh and yet it does not absorb any asphalt from solution. On further examining this dust, it was found to be most remarkable in that after mixing with a hot asphalt cement it produced a dark brown powder that judging from appearances you would think had an insufficient quantity of asphalt cement and yet when this powder was put under pressure in a mold pure asphalt cement squeezed out of it. It also has other pecu-

*See Bancroft's Applied Colloidal Chemistry.



Illustrating The Difference In Absorptive Values of Two Sands For Asphalt Cement. See Text For Explanation

liar properties which I have not the time to mention here but which go to show that there is a tremendous difference between the surface energy of the mineral particles of this dust and the mineral particles of the clay soil. When the asphalt cement has been absorbed by many clayey soils, it is so strongly held by them that it cannot be dissolved out with carbon disulphide.

So as to illustrate to you the great difference in the absorptive values of some sands for asphalt cement I have made up mixtures from two sands both with practically the same amount of voids but with different amounts of asphalt cement.

Three pat papers made up under the same conditions with these two sands which I will designate as A and B show: No. 1 a dark stain when sand A is used with 12.5% bitumen; No. 2 a light stain when sand A is used with 10.5% bitumen and No. 3 also a light stain when sand B is used with 12.5% bitumen. You can readily see the great difference in the character of these mixtures which must be due to the difference in surface absorption of the mineral particles. One of my first experiments on surface conditions of sand grain carried on about 1904 was to show that the roughness of the sand grains was not necessarily a dominant factor in the thickness of the asphalt film it would hold.

I took three sands, one from Sandusky Bay, Lake Erie, the other from Nutley Hall on the Potomac River below Washington and the other crushed pure quartz. These three sands were first washed thoroughly and all 200 mesh material screened from them. They were then separated into their several meshes by sifting and recombined so as to be of the same mesh composition. They were then separately mixed with 10% of asphalt cement and pat tests made of these mixtures in the usual manner. The Lake Erie sand gave a dark stain, crushed quartz a medium stain and the Nutley Hall sand a light stain. The crushed quartz had the highest per cent of voids and the roughest and most angular shaped grains and yet it took less asphalt to coat these grains than in the case of the Nutley Hall sand which was comparatively round. I could go on and mention numerous other experiments which show the selective absorption of different sand grains for asphalt cement but I think I have said sufficient to convince you that it is one of the most important factors influencing the design of asphalt mixtures and yet we know little or nothing about it. I know of no investigations having been carried on on this subject. Mr. Richardson over twenty years ago showed by his writings that this factor had an important influence on the designing of asphalt mixtures. It is this unknown factor which prevented his stating more definite conclusions as to the design of asphalt mixtures and for which he has been criticised. Of course we all know that he did give what he considered was a model mixture but he states that the quantity of bitumen must be regulated to the requirements of the particular sand. Mr. N. F. Macnaughton in his thesis for a fellowship printed in the Canadian Engineer May 9th to June 2nd, 1925, in alluding to Mr. Richardson's book states: "It is interesting to note that, though he described rather accurately the problems which must be solved before any exact definition could be made of the theory of sheet asphalt mixture design, he did not solve them." I entirely agree with Mr. Macnaughton and some of

these problems are very vital to the proper design of a sheet asphalt mixture, as I hope I have been able to show you, yet the present day student has not even attempted to solve them.

The void theory on asphalt mixtures was worked out and tried out over twenty years ago. Experimental pavements were laid with high dust and low bitumen but while they were more stable, other characteristics made them undesirable excepting for use under abnormal conditions which are seldom met with even in the traffic of today. The main objection to such mixtures is well stated by Mr. Skidmore: "Samples taken from the work showed extremely high density and whenever the bitumen content happened to run a fraction of a per cent more than that just required to fill the voids, the pavement flushed under the rollers and the rakers complained of the material being too stiff to rake readily." This fact is also very nicely demonstrated in the work of Hubbard and Field* in their paper read before the A. S. T. M., where it is seen from their diagram that the higher the per cent of filler the more rapid is the drop in stability with changes in bitumen contents. Another disadvantage is that the pavement will not have the life and enduring qualities that can be obtained from a mixture containing more bitumen.

Sometime before 1906 Mr. Walter S. Wilkinson, President of the International Paving Company, a company which at that time controlled nearly the entire asphalt block industry of the world, made a number of experiments with mixtures containing high dust (20% and over) and low bitumen. Some of these mixtures were tried out under abnormally heavy traffic with more or less success but the advantages were not sufficient to outweigh the objectionable features, among these being the difficulty of handling on the street owing to their stiffness and the shortening of the life of the pavements by the reduction of the bitumen. However, he made an interesting discovery while carrying on these experiments which he patented in 1906. He found that he could increase the stability of the mixture and lower the bitumen contents by mixing a large quantity of limestone dust with hot asphalt cement and then mixing this mortar, so to speak, with the hot mineral aggregate. This did away with the objectionable feature of cooling the aggregate by the addition of a large quantity of cold dust and at the time seemed to produce a more stable mixture. Sections of pavements were laid made in this way and while they apparently gave better results than a similar mixture made by the addition of dust to the mineral aggregate, yet their advantages were not sufficient to make them attractive to the sheet asphalt industry. A few of the asphalt block companies did use this method in the course of the manufacture of their mixtures but I understand that at the present time it is now only used occasionally for the manufacture of blocks to meet certain special conditions. Confidence may be placed in the conclusions arrived at by the asphalt block companies, for they have spared no expense in research work which has been carried on by educated chemical and mechanical engineers who were eminently qualified. Even though stability is a far more important factor in block than in sheet asphalt, yet the asphalt block industry does not find it practical or desirable to manufacture block with the highest stability obtainable nor have they found that high stability is the dominant factor but rather a blending of stability and pliability.

There have been a number of papers written recently on methods of determining stability and as was to be expected the various methods show that by increasing the filler and diminishing the bitumen a greater stability is obtained. There surely is nothing new in this idea and it has been known for over thirty years to my knowledge, yet because it has been suggested that the present day pavements should be more stable many engineers have jumped to the conclusion that high stability is the most important consideration in sheet asphalt pavements.

The study of stability is by no means a new subject. In 1895 Mr. Richardson in starting his investigation of asphalt pavements for the Barber Asphalt Paving Co. used a method by which he forced a plunger into a 2″ cube of the mixture at a standard rate of speed and measured the maximum power required. The 2″ cubes were molded under a definite pressure. Innumerable tests were made but he never published an account of his work and I have never heard what results were obtained. He did tell me that in some cases they verified conclusions that he had arrived at from practical experience. Messrs. Hubbard and Field's method is greatly to be commended because of the accordance of their results and the fact that it demonstrated in the laboratory conclusions that had been arrived at by practical experience and therefore greatly facilitated laboratory investigation of various types of mixtures. I believe a great deal of interesting knowledge can be gained from a systematic study of mixtures and pavements by their method but no definite conclusion should be drawn from these tests without knowing what relation they bear to practical experience. Mr. Macnaughton's method of penetration has been used for many years both in the laboratory and on actual pavements in the street. Over 22 years ago the asphalt block companies used a definite size steel rod which they penetrated into mixtures under a definite weight and at different temperatures. I am told that this test is not entirely satisfactory because it does not always indicate the most stable mixture.

*A study of certain factors affecting the stability of asphalt paving mixtures, by P. Hubbard and F. C. Field. 1926 proceedings of the American Society for Testing Materials.

In this paper I hope I have shown you that for many years both intelligent laboratory work and practical experience have been used in the development of the sheet asphalt pavement and that all the recent so called new developments in mixtures have been studied in the past from the theoretical as well as the practical side without having greatly influenced the industry.

It has long been the established principle that an aggregate should be designed to hold a good quantity of bitumen, 10% or higher, and to have the asphalt cement as soft as possible and yet have sufficient stability in the mixture to meet the traffic conditions. I want to warn you that you are materially lessening the life of your pavements by making anything like a general practice of cutting down the bitumen as low as 9.5%. Such pavements look well for the first few years, even up to 12 years in one case that I have in mind, but they age rapidly after that and soon disintegrate.

That such drastic change in formula of paving mixture is unnecessary is well illustrated by pavements that have been laid under one supervision and inspection. Several million square yards have been laid with a formula calling for 11% bitumen and over. All of these pavements are subjected to heavy traffic. Except for a few places not over 100 square yards in area, no rolling has occurred. The defective areas have all been due to failure of foundation or excessively rich spots. Other pavements made with sand carrying normal or low bitumen are made under formulas calling for from 10.25% to 10.75% bitumen with no cases of rolling and many of these pavements are in the vicinity of New York and are under exceptionally heavy traffic.

It is our general practice when we find a sand that will not hold bitumen to endeavor to find means of making it hold more and still keep the pavement sufficiently stable to meet the conditions to which it will be subjected.

Is it not far better to do this than to materially reduce the bitumen below what has been considered standard practice in the past as is now being done in several places in this country? At the very best such pavements should be classed as experimental and should be given a trial under different traffic conditions for at least five years before they are universally accepted and considered as good practice.

Farmers Buy Radios at Least

Twenty-five per cent of all farms in the United States are equipped with radio receiving sets, according to a census conducted by the U. S. Agriculture Department.

Ninety-six per cent of the farmers of New Jersey "listen in." In Rhode Island 80 per cent, in Ohio 56 per cent, in Massachusetts 56 per cent, in Iowa 45 per cent, in Colorado 44 per cent, in Indiana 42 per cent, in Montana 42 per cent, in Kansas 37 per cent, in North Dakota 36 per cent, in California 36 per cent, in Vermont 34 per cent, in South Dakota 32 per cent, in Missouri 30 per cent, in Oregon 29 per cent, in Nevada 29 per cent, in Minnesota 29 per cent, in Illinois 29 per cent, in New York 29 per cent, in Washington 26 per cent, in Wisconsin 26 per cent, in Ohio 26 per cent, in Maryland 25 per cent, in Connecticut 24 per cent, in Utah 23 per cent, in Michigan 23 per cent, in Idaho 22 per cent, in Maine 21 per cent, in Pennsylvania 21 per cent, in Wyoming 20 per cent, in New Hampshire 15 per cent, in Oklahoma 14 per cent, in Arizona 13 per cent, in West Virginia 12 per cent, in Tennessee 10 per cent, in Texas 9 per cent, in Delaware 9 per cent, in New Mexico 7 per cent, in Kentucky 7 per cent, in Virginia 6 per cent, in Florida 6 per cent, in South Carolina 6 per cent, in Louisiana 4 per cent, in Arkansas 3 per cent, in North Carolina 3 per cent, in Mississippi 2 per cent, in Alabama 2 per cent and in Georgia 2 per cent.

Radio seems to have spread swiftly to virtually every farm community throughout the United States. It is unlikely that any other home device has sold itself to the agricultural regions as quickly, the official reports indicate. The number of farms that lack electric light and power is large. The telephone is long in reaching a large proportion of farms. But in three years the number of farms possessing radio sets has grown from one in each 17 to one in each four.

The farmers buy high powered receivers in larger proportion than city dwellers. In general, they enjoy better reception than urban communities. They are quick to record their criticisms of the programs, the Agricultural Department radio bureau has learned.

New York Stone Association Plan Midsummer Meeting

The New York Crushed Stone Association will hold their big midsummer meeting in Rochester on Friday, July 22. An inspection trip is planned to the Dolomite Products Company's new plant. The program also includes an outing at Manitou, on Lake Ontario.

George E. Schaefer is president of the New York State Crushed Stone Association; E. B. Johnson, vice president, and J. H. Odenbach, secretary and treasurer. Several officers of the National Crushed Stone Association are expected to be present at the meeting in Rochester.

Porous Slag Stone

Fluid slag is cooled by pumping through it a stream of steam or gas which causes it to harden in porous masses, and finally cooled with water.—H. Mehner (German Patent 442,917).

DYER AND KANE CUT OPERATING COSTS BY EFFECTIVE MAINTENANCE

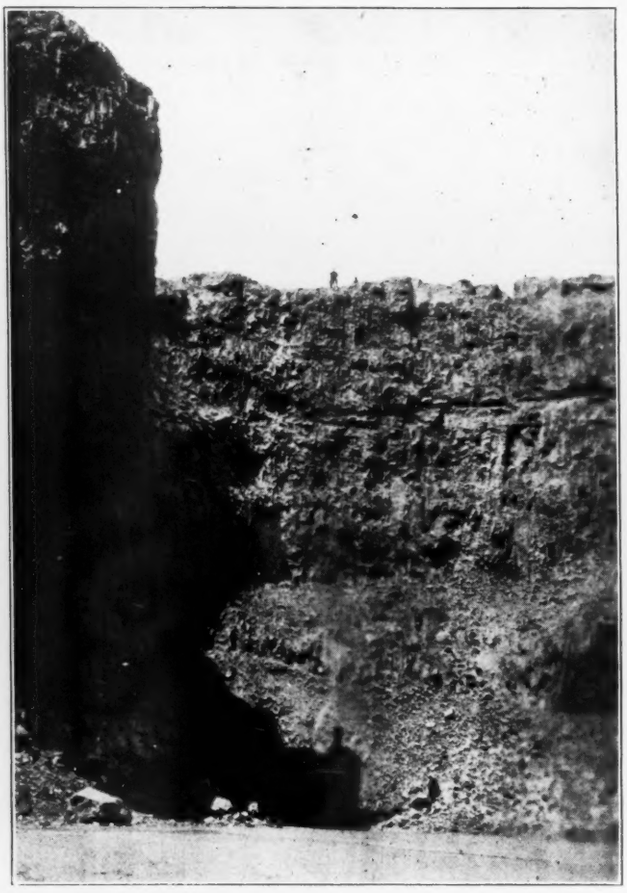
AMONG the numerous trap rock quarries in the Metropolitan section of New Jersey is one on the Valley Road, in the town of Ridgefield, owned by Dyer and Kane, from which the material is used almost entirely by that contracting organization. It is a modern plant yet it has been in operation for many years and perhaps one of the most interesting features about it is the long service which has been given by some of the machinery.

One of these machines is a Chicago Pneumatic compressor which has been used for twenty years and is yet in good condition. This compressor is driven by a 75 h.p. Westinghouse induction motor which was originally a direct current motor but was rewound for induction type. One of the Autocar trucks, in the quarry, has been in service for four years and is expected to give much more service. Other equipment at the plant has also seen long service. Of course the reason for this satisfactory service is careful maintenance, which means regular inspection, lubrication and attending to necessary repairs. An effective system of maintenance has reduced operating expenses.

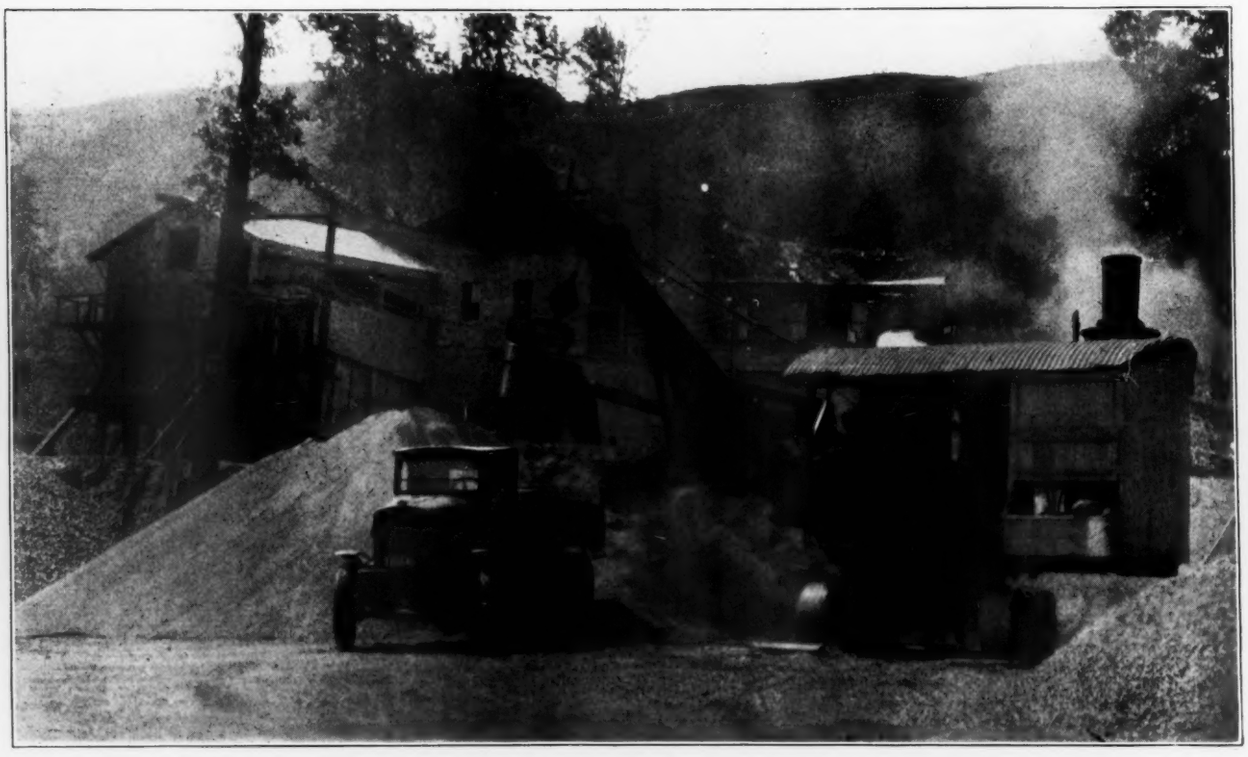
The quarry is a large one, the breast varying from 80 to 100 feet in height, and there is so little overburden that stripping is done by hand. Drilling is by means of four Wood tripod drills. Rock is taken out in benches, the holes being 20 feet deep, 6 to 8 feet back from the face and 3 to 6 feet apart,

Upper Right—Dumping Quarry Stone into Primary Crusher. Center—General View of Crushing Plant and Bins
Below—Loading Stone at Working Face of Quarry

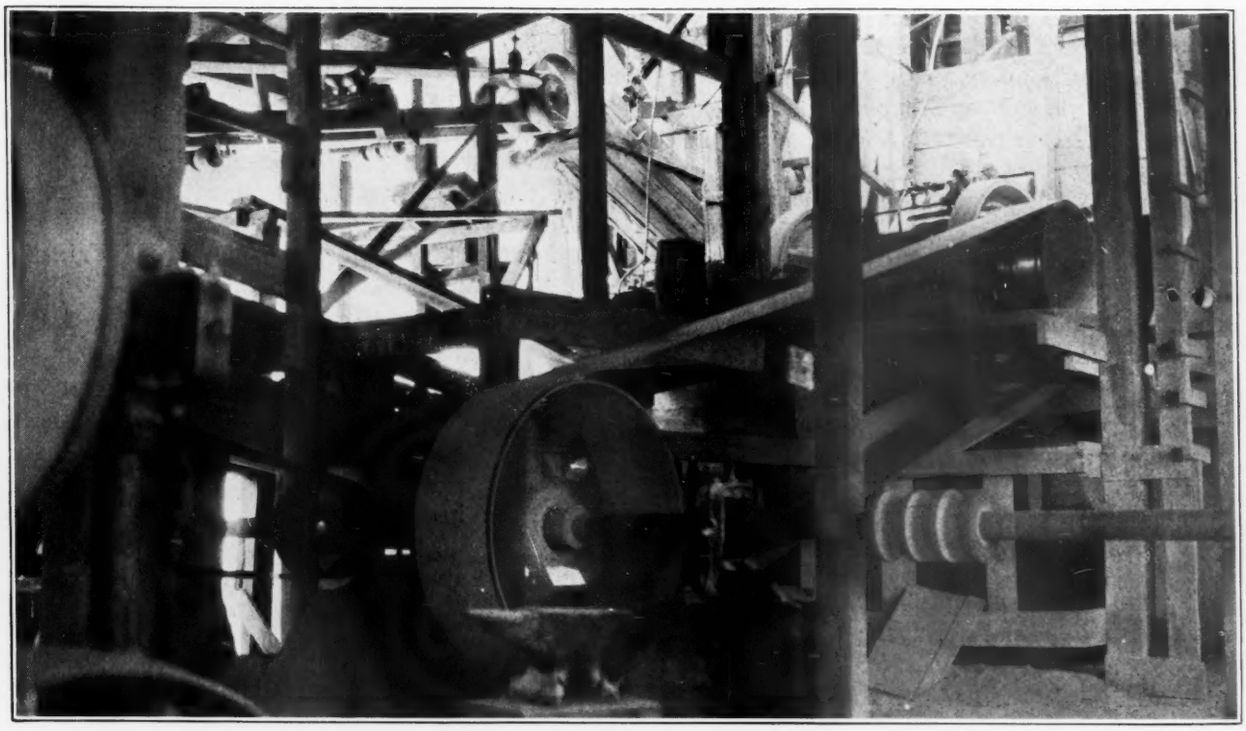
Drilling at Top of Quarry



View of Breast of Quarry. Note Shovel at Bottom and Drilling Crew at Top



Loading Trucks from Stock Pile with Steam Shovel



The Secondary Crusher

and fifteen to eighteen of these holes are fired at once with 60 per cent Atlas dynamite. The floor of the quarry is kept clean and free from pieces of rock, and this is advisable because the stone is taken from the working face to the primary crusher by the Autocar truck. The truck is loaded by a Thew steam shovel.

Quarry stone is dumped by the truck into the chute leading to a Reliance primary crusher which is located just below the floor of the quarry. From the crusher the stone is carried on a 16-inch Goodyear belt, on 70-foot centers, to the revolving sizing screen. The oversizes from the screen are then returned to an Acme secondary crusher by another Goodyear belt 14 inches wide and 75 feet between centers. The secondary crusher discharges into a 16-inch belt which carries the material to the screen. The crushing and screen plant is driven

View of Primary Crusher

by a Dick belt from a 125 h.p. Westinghouse induction motor. This belt is a new one and recently replaced one of similar make which had been running for four years. At this plant all transmission belts are purchased from the Dick Company and all the conveyor belts are Goodyear.

The storage bins are not of sufficient size to carry much surplus material, consequently it is necessary to make stock piles. These are formed by trucks which dump the material from a terrace which has been made by taking advantage of the natural slope of the mountain side, and also with the help of a second Thew steam shovel. The latter shovel is also used for loading the trucks. The plant has a blacksmith shop in one corner of the quarry where the drills are sharpened and any light repairs made on machine parts. Compressed air is ordinarily used for the forge but a Champion hand blower has been provided as a reserve. The drills are sharpened by hand. In one of the buildings of the crushing plant is a Myers centrifugal pump used to force the water to the steam shovel operating in the quarry.

Automobile Taxes Estimated

Automobile owners and operators paid approximately $697,000,000 in taxes to the federal and the 48 state governments in 1926, according to data compiled by the National Automobile Chamber of Commerce. Approximately $96,000,000 was collected by the Washington tax levying authorities, it is reported, as a sales tax on new cars, trucks and accessories purchased during the year. This amounts to about fourteen per cent of the total paid by car owners to all governments.

The governments of the 48 states divided among themselves a total of $601,000,000 in three principal levies, according to the association's data. The largest levy was on licenses for cars and operators. This totaled $288,000,000 and amounted to 41 per cent of the total paid by the motorists.

The collections by the states on gasoline totaled $188,000,000 or 27 per cent of the whole. Most of this money went into road construction and repair. About $125,000,000 was collected by the states as personal property levies on the motor cars. There now remain only two states not collecting a gas tax, so the figures for 1927 will be larger.

In addition to the taxes collected by the federal and state agencies, municipal authorities took about $15,000,000 in fees and taxes of different kinds.

Bleaching of Minerals

Minerals such as clay are suspended in water and bleached with an acid salt of sulphurous acid, such as sodium bisulphite or meta bisulphite, in the presence of a metal which reduces sulphurous acid, such as zinc or aluminium.—W. Feldheimer (German Patent 443,231).

Strength Tests of Portland Cement

Strength tests on control samples of portland cement carried out at the laboratory of the German Portland Cement Manufacturers' Association during 1926 were reported recently. In all 250 ordinary and 43 super portland cements were purchased in the open market and tested for their conformity to the standards. The average values obtained are given in the tables which follow.

TABLE I

Ordinary Portland Cement—Average Values

	1926	1925	1924	1923
Residue on screens				
75 meshes per linear inch .... (900 meshes per sq. cm.)	0.5	0.6	0.5	1.0
175 meshes per linear inch .. (4,900 meshes per sq. cm.)	13.0	13.6	14.3	16.6
Weight per liter (i.e. *apparent* spec. gravity)				
As poured into vessel	1.089	1.077	1.082	1.089
Tamped down	1.764	1.767	1.719	1.674
Specific gravity				
As purchased	3.026	3.017	2.970	3.016
On ignition	3.128	3.120	3.050	3.084
Setting properties				
Initial set (hours)	4° 37′	4°	3° 30′	3° 20′
Setting time (hours)	7° 53′	6°	6° 45′	6° 40′
Tensile strength				
1:3 Standard sand	Pounds per square inch			
7 days water test	340	345	325	285
28 days water test	418	430	430	364
28 days combined test	568	573	562	549
Compression strength				
1:3 Standard sand				
7 days water test	3,864	3,671	3,231	2,984
28 days water test	5,280	5,088	4,330	4,060
28 days combination test	6,325	6,023	5,253	5,115

TABLE II

Super Portland Cement—Average Values

	1926	1925
Residue on screens		
75 meshes per linear inch	0.1%	0.1%
175 meshes per linear inch	4.8%	4.9%
250 meshes per linear inch	13.3%	13.5%
Weight per liter (i. e. *apparent* specific gravity)		
As poured into vessel	1.034	.....
Tamped down	1.746	.....
Specific gravity		
As purchased	3.052	.....
On ignition	3.124	.....
Setting properties		
Initial set	3 hrs 20	3 hrs 18
Setting time	6 hrs	5 hrs 6
Tensile strength		
1:3 Standard sand	Pounds per square inch	
3 days water test	406	389
7 days water test	469	435
28 days water test	528	484
28 days combination test	634	623
Compression strength		
1:3 Standard sand		
3 days water test	4,771	4,318
7 days water test	6,146	5,734
28 days water test	7,453	7,109
28 days combination test	8,608	8,484

Handbook Worth Weight in Gold

H. M. Siebert, general manager of the Ohio Lime and Stone Company, writes: "Many thanks for the excellent Handbook; it is worth its weight in gold." The Ohio Lime and Stone Company have been doing some experimental work on a colored finishing lime which probably will result in a new important product for the company.

STRENGTHENING AND WEAKENING OF MORTARS

By Dr. Ing. Heinrich Luftschitz, Dresden*

IT IS known that iron, an element of the atomic weight 56, can be converted into the well known varieties of steel, steel 48 and silicon steel, by the introduction of small amounts of elements of a low atomic weight such as carbon (atomic weight 12) and silicon (atomic weight 27). These varieties of steel have a particularly high tensile strength and tenacity.

The thermal expansion of these varieties of steel, however, has not been ascertained up to the present, but it may be assumed that substances which, like silicon steel, exhibit a strong resistance to the disintegration of the internal texture on the notched bar shock test on a brief load, will also behave favorably in regard to thermal expansion. Taken in a broad sense and on the whole the space changes on heat and cold are comparable to the requirements of the notched bar shock test, as in that case also the structure, while expanded with time, will also be drawn in varying directions.

In the non-metallic domain of building materials there are none which combine a high tensile strength with a low thermal expansion. There is only a single substance, which, however, strictly speaking, is not a building material, namely hard porcelain, which with a tensile strength of from 200 to 300 kg/cm² possesses a thermal expansion co-efficient of from 300 to 400.10^{-8}, as a result of which it is immune to destruction for an indefinite length of time, that is to say from disintegration of the interior structure. In comparison with the thermal expansion co-efficients of cement with 1100 to 1300.10^{-2}, and tensile strength of only 40 to 45 kg/cm² in an attenuated, and from 50 to 70 kg/cm² in an unattenuated condition, porcelain may be considered as an ideal which must be striven for in the field of cements.

It will now be seen, that, also, in the field of cements, as the result of the introduction of elements of a low atomic weight, such as silicon and aluminum, compounds have been obtained which exhibit a steady improvement in quality when compared with those formerly known.

In the case of the stone-like building materials, unlike the case of the metallic, we are, however, not concerned with a combination of elements, but on the contrary with a combination of their oxides. Silicon and aluminum are introduced in the form of oxides into calcium, an element of an atomic weight of 40, this latter being also in the form of an oxide.

From illustration number 1 will be seen the development of Portland cement, gradually, from pure white lime. Square representations are seen and in these the different elements are represented by shades in the form of oxides. Silicon, that is to say in the form of its oxide, silica, is represented by red, the aluminum and alumina, respectively, by blue, the iron by yellow. White lime is not a cement which hardens under water. In order to enable it to do so the ancient Romans added to it substances such as trass which contain silicon, that is to say, silica in a form capable of combining.

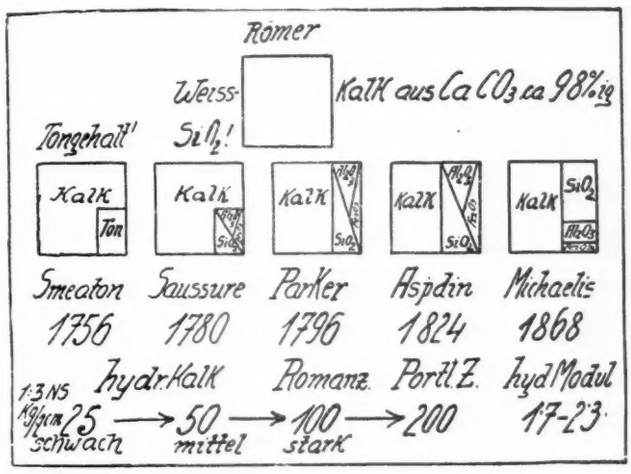


Figure 1. Development of Portland Cement

In 1756 the English engineer Smeaton conceived the idea of using, in the construction of the Eddystone lighthouse, a lime which was to be possessed of best qualities as far as lime went at that time. He happened to obtain a lime which on the treatment with hydrochloric acid left a residue which was found to be clay. In 1780 the Frenchman Saussure found that the silica of the clay is the constituent which hydraulicizes lime, that is to say, gives it the property of hardening under water. While engaged in a search for lime with a largest possible content of clay, Parker, an Englishman, in 1796 came across lime kidneys which upon burning gave a very strongly hydraulic lime with a mortar strength of approximately 100 kg/cm² (1:3), which signified a decided improvement in quality in comparison with the old Smeaton lime as a representative of a mildly hydraulic lime. A still further increase amounting to 100 per cent in comparison with the product obtained by Parker, and designated as Roman cement, was achieved in 1824 by the discovery of Portland cement by an English mason of the name Aspdin. At the outset it was an empirical product. At a later period the German investigator Michaelis gave an important impetus to the rational or synthetic manufacture

*Translated from Zement, May 12 and May 19, 1927.

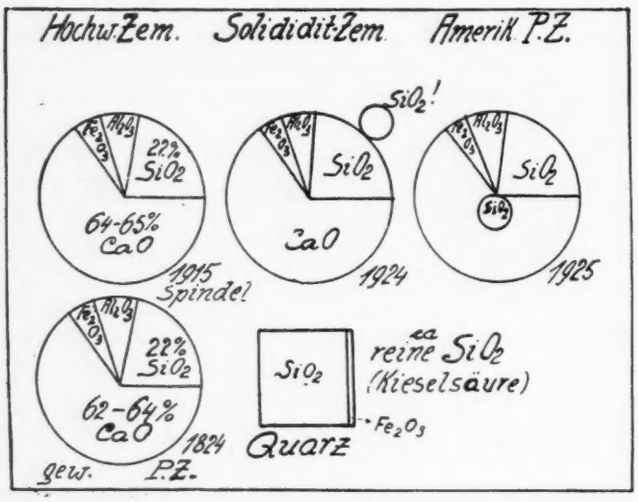


Figure 2. High Grade Cement and Portland Cement Rich In Silicic Acid.

of Portland cement, establishing the mathematical limits for the raw materials necessary in the production of Portland cement, that is to say, limestone and clay, and fixing the hydraulic modulus. The development of Portland cement shows very distinctly the continued increase in silicon content in the form of silica.

Illustration number 2 shows the further evolution taken on by Portland cement.

The endeavor to further improve the quality of Portland cement has been along two lines. The one has led, chiefly on a mechanical basis, to the production of the high grade Portland cement turned out since 1913 in Austria, the other on more chemico-physical bases to a Portland cement the superior quality of which is due to consideration of the silicon content and increase of the latter in the form of silica, which has made for better results, especially with reference to tensile strength and spacial stability. Soliditit-cement is produced by the addition of ignited quartz (sand) to ordinary Portland cement. It is not improbable that not only the increase in silica content, but also the physical change due to ignition, contributes to an increase in the tensile strength. American Portland cement differs from the German product by a somewhat higher silica content originating from the raw material. Accordingly, whether the addition of silica is made to the finished cement, that is to say afterwards, or to the raw material before the burning, small circles will be seen in the illustrations, which sometimes are outside of the large circles, at other times inside the same. The years given in illustration number 2 indicate the time at which the practice originated.

In high grade cement we have a product which is produced to a lesser extent on a chemical than on a physical basis. From a chemical point of view, in the preparation of the same, thought is given only to the use of the best clay and the best limestone. A finer grinding in the production of the raw meal and a more intensive burning are the special characteristics in the production of this type of cement. The nature of high grade cement depends upon the potentialization of energy which becomes active in its use. This effect can be noted in the shrinkage of high grade cement, which displays a degree of self-condensation in the interior.

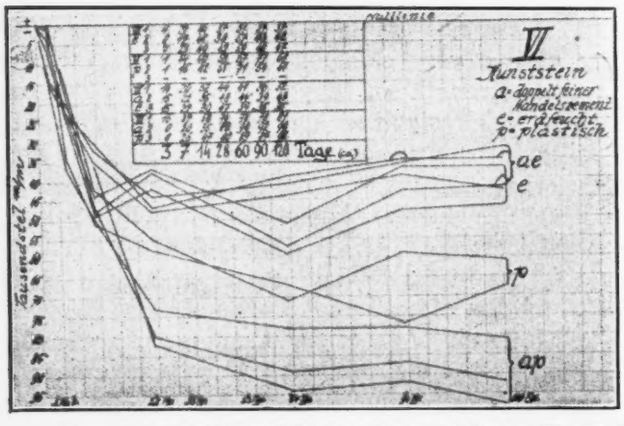


Figure 3. Artificial Sandstone From Ordinary Portland Cement

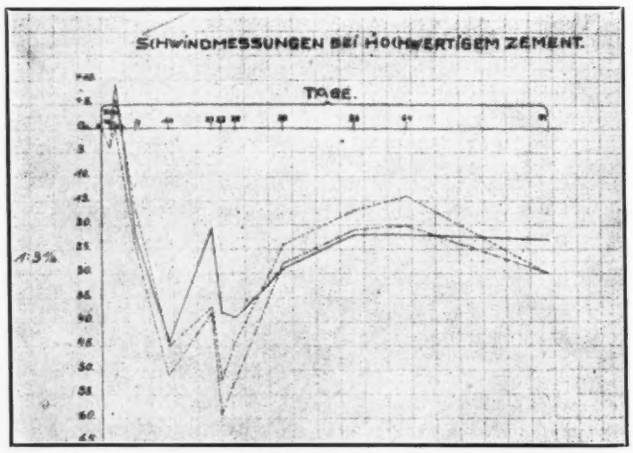


Figure 4. Artificial Sandstones From High Grade Portland Cement. Shrinkage Measurements of High Grade Cements

Illustration number 3 represents an artificial sandstone made with ordinary Portland cement. The shrinkage curve progresses gradually, so that, practically considered, a cessation of the self condensation can be counted upon in 3 or 4 months' time.

In illustration number 4 is depicted the same kind of artificial stone made with the use of high grade cement. Here it will be seen that a strong self contraction, i. e., shrinkage, has set in very early. It is a fact that the practical maximum strength about coincides with the time of the internal shrinkage, as can be established by the shrinkage curve.

The silica having been dealt with chiefly up to the present, another color will be seen to predominate in illustration number 5, namely blue, representing aluminium or alumina. It is to be understood that in the case of hydraulic cements and cements in general we are not considering the oxides as such, but are dealing with complicated

compounds usually designated as calcium silicates and calcium aluminates. In the illustration to the left we see aluminous fusion cement which is distinguished from Portland cement by its high content of alumina. It was first prepared practically by the Frenchman Bied in 1908, some German scientists having worked on the subject previously. Most recently cements have appeared which bear a slight relation to aluminous cement in so far as they show an increased alumina content due to the employment of bauxite, from which otherwise, in combination with limestone, the normal aluminous fusion cement is produced.

These new cements are the bauxite land cement put out in Germany around 1924, and the Kühl cement produced at present in Austria, according to a patent of Prof. Dr. Kühl of Berlin, and intrinsically identical with the first. In the illustration, accordingly, in the large circles of these cements the minority alumina content is given sometimes outside, sometimes inside the big circle, in

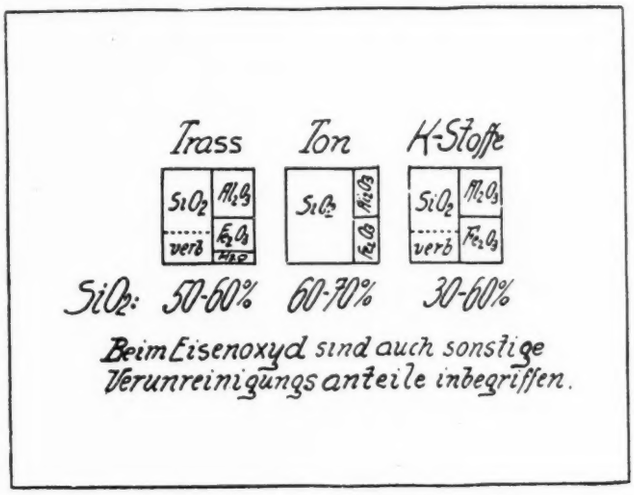


Figure 6. Silicic Acid Substances

order to indicate that it is possible, similarly to the case of silica cements, to either add small amounts of bauxite to the finished cement or to add it to the raw meal before burning to obtain cements of this type, though the latter method is utilized in practice.

In referring to the development of Portland cement from white lime, mention was made of the ancient Romans bringing about a hydraulization of lime by the addition of trass.

In illustration number 6 will be seen substances which chemically speaking are similar to one another and characterized by a content of silica, to the right trass, in the middle clay, and then what may be designated as "K" substances (silica substances). The content of these latter substances of silica capable of combining is, as will be seen from the illustration, variable.

In illustration number 7 is a grouping of such substances.

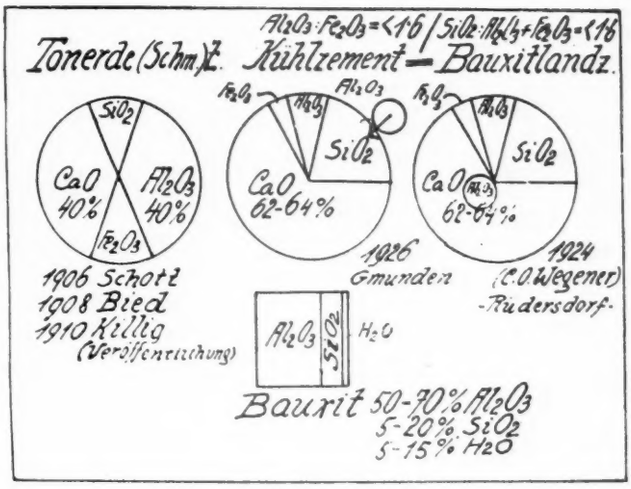


Figure 5. Aluminous Cements

It is an interesting question, what will the result be when such substances are combined on the one hand with Portland cement, and on the other with white lime?

In illustration number 8 it will be seen that the "K" substances are capable in many instances of strengthening and in many cases of weakening Portland cement. Ordinarily, from such substances, a strengthening of Portland cement is to be expected only when there is present an amount of free lime sufficient to combine with the silica capable of combination contained in them. This constitutes the chemical strengthening which often is evident, especially in mild burnt cements.

In many cases, in the addition of such substances to Portland cement, the object in view is not so much to attain a strengthening as will be seen on the left side of the illustration, but to obtain cements which still possess a sufficient strength for certain purposes.

In the case of Si-substance I have recently succeeded by the addition of moist Si-substance to incandescent cement clinker in obtaining a cement

K-Stoffe	SiO_2 %	v. SiO_2 %	Al_2O_3 %	Fe_2O_3 %	CaO %	MgO %	Glüh %	H_2O %
R-Trass	58	20	15	3	2	1	9	7
B-Trass	66	15	16	7	3	1	2	6
Cemolit	57	18	20	4	3	½	11	4
H-Asche	48	16	33	8	5	1	3	–
Link-Trass	Hochofenschlacke + Ziegelmehl							
Thurament	Hochofenschlacke + ?							
Si-Stoff	66	36	16	3	½	½	1	11
Jurament	Ölschieferrückstand ?				Asche ?			
Sohldidit-Zement	Zement + geglühter Quarz (Sand) (event. SiO_2-Gestein)							

Figure 7. Composition of Silicic Acid Substances

M-Material		STÄRKUNG Z	M	S	Druckf. kg/qcm	Monate	Schwächung Z	M	S	Druckf. kg/qcm	Monate
R-Trass	Sciss.	1		2	308	1	2/3	1/3	3	868	1
		3/4	1/4	2	319	1	1/2	1/2	3	540	1
	Scav.	1		2	298	1	1/3	2/3	3	372	1
		3/4	1/4	2	338	1	1/4	3/4	3	218	1
							1 x)	–	3	1800	1
B-Trass		1	0.3	6	368	1	1	–	6	3540	1
		1	–	6	354	1	0.7	0.3	6	3140	1
Si-Stoff							1		3	3580	1
"							1/3	2/3	3	2944	1
"	☒	4/5	1/5	3	3200	☒	4/5	1/5	3	2373	1
"	☐	1	–	3	2300	☐	Zugf. 17 kg/qcm (7 Tge)				
	☒	Zugf. 27 kg/qcm (7 Tge)				☒	Zugf. 18 kg/qcm (7 Tge)				
Cemolit							1		3	4710	1
"				Norm 250			→ 2/3	1/3	3	3830	1
"		1	0.6	3	5175	12					
"		1	–	3	3405	12					
H-Asche		0.6 x)	0.4	3	2880	1	0.43	0.6	3	2680	1
Thurament		1	0.4	4	2680	Wirkung → Hochofenzement!					
		1	0.8	4	3910						
		1/2	1/2	3	3150	1	1/10	9/10	3	1400	
Solididit		erhöhte Zugfestigkeit (SiO_2! – Quarz									
Amer. PZ		etwas höhere Zugf. wie deutsch. PZ (SiO_2)									

Legende:
x) absichtlich abgelagerter Zement oder schlechter Sand ! hoher Al_2O_3-Gehalt!
☐ Klinker für sich gemahlen
☒ " mit bei 105° getrocknetem Si-Stoff
☒ " (50% feucht) geglühtem Si-Stoff

Si-Stoff wirkt bei Zementen in geringen % Sätzen (2–10) am besten – bei Kalken: 25–75 %!

Figure 8. Silicic Acid Substances and Portland Cement

having an increased tensile strength and also a higher crushing strength, as will be seen from the chart. The tensile strength of 17 without Si-substance was increased to 27 with Si-substance in a few days. In the case of Hirschfeld lignite coal ash, which is very closely related to natural trass, the property is shown in the possibility of weakening the cement to the level of ordinary cement in case of a replacement of about 50 per cent by weight of the latter. In the case of thurament the strengthening influence exceeds that of trass. It is caused by the chemical nature of the slag, which as such is already closely related to cement through its fineness and its silica content. Trass from the Rhine, Bavarian trass, and cemolite are nature products of volcanic origin. Si-substance is a by-product of the alum industry, clay being treated with sulphuric acid in order to convert as much as possible of the alumina present in it into aluminium sulphate and alum. Alum is soluble in water and is separated from the insoluble residue of the clay. The latter constitutes the Si-substance. Thurament is a material consisting almost wholly of blast furnace slag.

In illustration number 9 will be seen again the "K" substances previously referred to, but in their combination with lime. Briefly expressed it will be seen from the column crushing strength that in the case of richer mixtures of lime and "K" substances we are dealing with the indirect production of hydraulic limes of about the quality of Roman cement. Some, however, such as thurament, produce materials ranging in grade up to normal cement, products which can be called "slag cements." From the illustration there can be seen furthermore, that only white lime, but also, particularly, dolomitic (i.e. magnesia) lime, and limes containing gypsum, such as gypsum lime derived from certain soft coal ashes containing calcium sulphate, can be improved, that is to say strengthened by means of "K" substances. In a particular case it

M-Material	Mischung M	K	S	Druckf. kg/qcm	Monate	Güte von:	andere Kalke 1:3 7 28 47 Zem K	7 28 64 dol. K	1132 Gips K	Streckg.
R-Trass	1/4	1	2	1360	1	Romanz			1440	50
" "	1/2	1	1 3/4	1000	1	"				
B-Trass	1	1/4	1.5	1100	1	"				
Si-Stoff	3/4	1/4	3	1210	1	"	992	906		66
Cemolit	1/2	3/4	1	1152	1	"				
Lin K-Trass	1/2	1	2	630	1	3/4 " später besser!				
H-Asche	1/5	1/5	3	1380	1	" Al_2O_3!			2308	50
Thurament	1	1	1	2150	1	1 1/2 " Hochofenschlacke!				
" "	1/6	1/6	5	3290	1	3 " wirkt wie Schlackenzem				
Vergleich Trass	1/6	1/6	5	690	1	3/4 "				

M = Kieselsäurestoff
K = Weisskalk
S = Sand
+ Werte ohne M

Figure 9. Silicic Acid Substances and Lime

was possible to strengthen a dolomitic lime of 0 kg strength under water to 206 kg/cm² crushing strength (1 : 3).

Having up to the present heard of the strengthening and weakening of Portland cement and lime, the question must arise: What will happen when two ready-made substances, such as Portland cement and lime, are combined?

This question is equally interesting from the chemical as well as from the mechanical point of view. This is especially so of the combination of limes with a magnesia content, i. e., dolomitic limes. In this case the idea might become apparent, whether the magnesia in the lime will exert an injurious effect on the Portland cement, as it is known that 5 per cent is the highest permissible magnesia content in Portland cement. With regard to this the present opinion of leading cement experts is that it is quite safe to work up Portland cement with dolomitic lime. In particular cases, of which we shall hear, this, however, is to be avoided.

From a mechanical point of view only a weakening of the cement and a strengthening of the lime, respectively, are to be expected upon the mixing of cement with lime. Of more importance, in such cases, is the economical question, whether the so-produced new material is profitable with regard to strength, or whether it is not more advantageous to strengthen the white lime with "K" substances instead of with cement, in order to arrive, for example, at a mild hydraulic lime or at a strong hy-

draulic lime, or whether there may not be available already cements of an equal character.

In illustration number 10 will be seen Portland cement which has been combined with 1, 2, 3, etc., parts by volume of lime. Furthermore will be seen, in a similar manner, hydraulic lime combined with Portland cement. As will be seen from the tensile and crushing strengths a progressive weakening results with increasing lime content.

Raumtl		Weisskalk				Hydr Kalk				
		Maschine		Hand		Maschine		Hand		
Zem	Kalk	Zugf	Druckf	Zugf	Druckf	Zugf	Druckf	Zugf	Druckf	
1	ohne	5	5							
1	1	25	29	08	05	28	31	12	06	
1	2	16	2	05	03	20	23	09	05	
1	3	09	1	04	02	19	18	06	03	
1	4	07	1	04	03	16	14	05	02	
1	6	05	08	02	01	08	10	05	02	
2	1	3	27	08	08	29	33	15	09	
Zugf. geteilt d. 10 Druckf. geteilt d. 100,										Faktorenwertstabelle

Figure 10. Portland Cement and Lime

It was of interest to determine to what extent weakening follows when the materials are mixed by hand instead of in the mixer. From the columns giving tensile and crushing strength it will be seen that considerable weakening results from hand-mixing.

In illustration number 11 the weakening is given in figures in fractions. The fractions indicate the strength attained without lime. In the working of white lime in the mixer with the Ammer apparatus, the progression of the weakening in the tensile strength will be seen, being given by the fractions 1/2, 1/3, 1/5, 1/7, and 1/10. They are less in the case of hydraulic lime. In the case of the hand-mixing it is interesting to note that in the case of hydraulic lime, i. e., lime rich in silica, the weakening is less than in the case of white lime.

In illustration number 12 another representation of the result is given. The tensile strength has been divided by 10 and the crushing strength by 100, in order to obtain the weakening in factors of figures with reference to the maximum values in the uppermost series.

The fact is well known that when brick are joined with mortar to form masonry work, a masonry work strength results which represents a fraction of the strength of the brick. This is also a weakening in the domain of building materials. In illustration number 13, to the left will be seen hydraulic lime mortar and to the right Portland cement mortar in combination with bricks, which viewed horizontally have the same strength, but viewed vertically, have a gradation of 200, 400 and 600 kg/cm². The hydraulic lime mortar itself has

Raumtl		Schwächung gegen Höchstwert							
		bei Maschine				bei Hand			
Zem	Kalk	Zugf.		Druckf.		Zugf.		Druckf.	
		W.	H.	W.	H.	W.	H.	W.	H.
1									
1	1	1/2	<1/2	1/2	<1/2	1/6	1/4	1/10	1/8
1	2	1/3	>1/2	1/3	1/2	1/10	1/5	1/16	1/10
1	3	1/5	<1/3	1/5	1/3	1/12	1/8	1/25	1/16
1	4	1/7	>1/4	1/4	1/4	1/12	1/10	1/16	1/25
1	6	1/10	<1/6	<1/6	1/5	1/25	1/10	1/50	1/25
2	1	<1/2	<1/2	<1/2	<1/2	1/6	1/3	1/6	1/5

Figure 11. Weakening of Portland Cement Expressed in Fractions

a strength of 15 and the Portland cement mortar one of 200 kg/cm². In vertical sequence will be seen the crushing strength which is met with in each individual instance. This is the masonry work strength. If the illustrations be compared it will be found that a brick of a crushing strength of 600 kg/cm² combined with a mortar of a crushing strength of 15 kg/cm² furnishes a masonry work strength of 80 kg/cm², like a brick of a crushing strength of 200 kg/cm² combined with a mortar of a crushing strength of 200 kg/cm².

The metals, specifically steel, have been taken as prototypes. In bridge construction the supporting members are joined together with rivets. Similarly, in building construction, building materials, such as brick and gravel, are joined by cement and mortar in a manner similar to that by rivets in the case of steel. This comparison may not be technically correct, but illustrates the production of a construction unit as a whole, made up of a number of separate individual pieces. This will become clearer upon referring to illustration number 14. To the left will be seen brick masonry work and to the right concrete. If we bear in mind the idea that

Raumtl		Weisskalk				Hydr. Kalk				
		Maschine		Hand		Maschine		Hand		
Zem.	Kalk	Zugf	Druckf	Zugf	Druckf	Zugf	Druckf	Zugf.	Druckf	Bemerk.
1	ohne	46·7	4688							1 Sand 3 Kies
1	1	24·6	2930	7·9	532	28·2	3130	11·5	616	
1	2	15·8	2176	4·5	29·5	20·2	2290	8·7	447	
1	3	9·3	1090	3·9	23·9	18·9	1760	5·7	250	
1	4	7·1	1112	3·9	31·4	15·7	1378	5·2	231	
1	6	4·9	824	1·8	12·6	7·5	950	5·0	200	
2	1	30·3	2700	7·7	78·0	29·4	3280	15·2	874	
	Kalk			3·9	10·7			5·7	11·2	Zugf. Druckf. kg/qmm 1 Sand 3 Kies

Figure 12. Weakening of Portland Cement Expressed In Relative Values

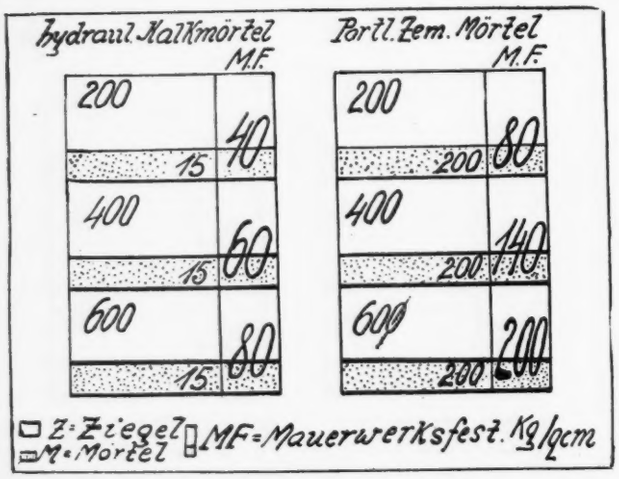


Figure 13. Brick, Mortar and Masonry Work Strength

the hardening of the cement and the mortar is due to contraction and the shrinkage due to condensation, it will be clear that the bricks in a masonry work as well as the gravel in a concrete are given a power which can be spoken of as a kind of riveting power, or as I said as early as 1912, a kind of inclusion power. It is identical with pressure force.

From this point of view we should endeavor, in the case of a cement, to maintain and to increase its riveting power.

The opposite is often done by choice of poor sand or a weakening is purposely effected for reasons of economy. In the illustration, this is emphasized by dots inserted in the mortar or cement gel which represent foreign materials, for example, clayey or humus substances in the sand capable of elimination by floating, as the result of which the original power of the cement gel can be reduced to one-half. It is also evident that when a piece of gravel impinges against such a clayey deposit, the pressure force or riveting power of such a piece of gravel will be nullified, resulting in a concrete of a poor strength.

With these remarks on the strengthening and weakening of cements, I will call attention to the fact that in the mixing of several substances to form a uniform whole, it is essential to always keep in mind the equilibristics of the materials with reference to their chemical and physical powers. In practical building industry, however, one meets with a lack of knowledge in regard to building materials.

Up to the present we have dealt with the strengthening and weakening of the two substances, Portland cement and lime, in their completion and combination. I shall now in a few words take up the subject of those strengthenings and weakenings which may become evident in an already executed building construction.

With reference to this I am bringing forth an example of chemico-physical action upon the mortar.

We have noted how Portland cement undergoes a weakening when mixed with white lime or with hydraulic lime. This weakening in the case of a completed building construction, such as, for example, a chimney, can progress still further, due to the production of gypsum from the lime by the action of the smoke gases which often contain large amounts of sulphuric anhydride. This, owing to an expansion in every mortar, is dangerous. In the course of time the joints disintegrate. On this account, a combination of one part of cement with 2 parts of lime by volume as a chimney mortar is in my opinion unsafe. The condition must become still more dangerous when in place of white lime, a magnesia containing lime, that is to say a dolomitic lime, is used, as the action of magnesium sulphate is particularly destructive on a mortar. Accordingly, if we wish to combine lime with cement, this must always be carried out in combination with a silicic acid substance, the effect of which is to combine with the excess lime. Portland cement alone does not contain any free silicic acid capable of combining with lime and prevents the lime from hardening naturally through absorption of carbon dioxide by enclosing it, the hardening being due to an extent of 99 per cent upon this.

Destruction through chemical influences often constitutes weakenings which are not taken into consideration beforehand in building construction. As an example of an evident strengthening in such a case, I can refer to a case in which waters containing carbon dioxide were a factor. In this case where lime is the constituent which removes the carbon dioxide from the mortar, it is to be endeavored to combine the lime by the addition of silicic acid substances, such as trass, etc., and at the same time by means of this aggregate to reduce the pores of the mortar. The same is the case with mortars in sea water, where the formation of calcium sulphoaluminates may become dangerous to the Portland cement.

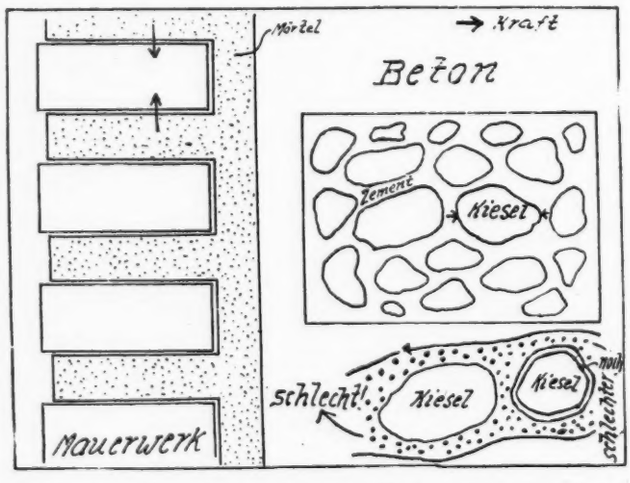


Figure 14. Comparison of Masonry Work and Concrete With Rivet Work On Iron and Steel

Heat and cold constitute important factors in the strengthening and weakening of a mortar.

In order to illustrate and make evident the action of heat in the case of cements reference is made to illustration number 15, which depicts the hardening of clay and the influence of heat upon clay and cement.

It will be seen that heat first brings about an increase in volume and then a decrease in volume in the sense of a strengthening while in the descending part of the curve a densification follows. Above the maximum on, the heat, whether in form of thermal expansion or liquefaction and subsequent evaporation, affects an extensive disintegrating action upon the structure which may amount to a weakening. In the case of cement such a weakening also causes a subsequent swelling on account of absorption of moisture. The former pore space has already become too small for this new increase of volume in the interior. Accordingly the strength decreases with an increased swelling. It is often possible to utilize heat to bring about the strengthening of a mortar, but this is not made use of by far to the necessary extent in the case of concrete. We are still today of the opinion that a temperature of — 3° C. (26.6° F.) and below is the temperature which is injurious to concrete. The fact is that a temperature of + 10° C. (50° F.) has already a certain influence upon concrete. Concrete is almost as sensitive as a human being as far as optimum temperature conditions are concerned.

An approved strengthening material against cold is found in calcium in the form of fused calcium chloride. It gives good service in shaft construction but it is dangerous to use an excess of the same. In the case of temperatures down to — 7° C. (19.4° F.) a water for mixing of a specific gravity of 1.07 containing 17 per cent of calcium chloride is the most suitable. The heat developed in this case has a favorable influence. A 20 per cent solution is already injurious on account of supersaturation (causing flotation.)

The strengthening of our mortars had seemingly taken a wrong course from which it had to be righted as soon as possible. The strengthening paralleled the demands of the time. There were until recently demands for an increase in the crushing strength. What Dr. Kühl in his earliest articles so aptly styles "the race between the cements and the crushing strength" must bring before us a horse race in which no longer swiftness and endurance, but only swiftness is valued. But in the case of building materials, it is endurance, rather, which is valued. Professor Spangenberg admonishes us in an article which has recently appeared in "Beton und Eisen" indirectly to strive for a bettering of the tensile strength.

In the domain of cement, the crushing strength is and remains dependent upon the lime. The tensile strength, on the other hand, as I have shown in the examples and will show again, seems to depend upon the silica and the alumina, that is to say, the acid constitutents of the cement.

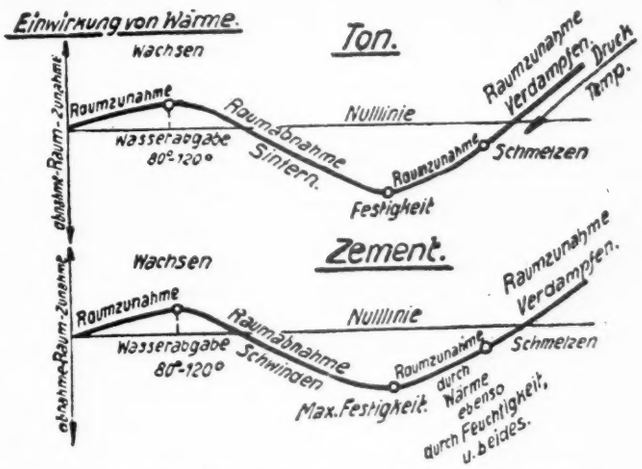


Figure 15. Schematic Comparison of the Action of Heat on Clay and Cement

I refer to the Soliditit-cement as an example in which we have to reckon with a quartz changed by ignition into substances of a low thermal expansion and thereby intimately disintegrated, offering a portion of free silicic acid for combination with the lime of the cement. It is, however, equally apparent that the ignited quartz will be rougher and sharper as far as the particles go than the ordinary, and consequently more liable to attack, with a resulting increase in the tensile strength of the concrete. Another example of seeming importance is the increase in tensile strength which I have shown to be brought about by the addition of moist Si-substance to incandescent clinker, a procedure which combines in a subordinate way the production of Solididit with that of the lime, sand, stone and slag granulation. A further example of the increase of the tensile strength of a concrete consists in the addition of porcelain fragments, which on account of the very small thermal expansion coefficient and the rough surface constitutes one of the best aggregates for road construction and also for chimney mortar where the costs are not too high. Its swelling, even in the presence of bases such as lime, is almost zero. Other substances containing amorphous silicic acid, such as trass, etc., are by means of their swelling properties converted by the excess lime into calcium hydro-silicate in excess in the interior of the concrete and may give rise to internal tensions in the concrete, if not immediately, in the course of years. And now I arrive at where I left off. The significance of the increase of tensile strength for the life of a mortar.

The demands which present themselves in this respect are: a high tensile strength with small thermal expansion and a minimum of subsequent swelling, which indirectly would mean that the latter increases the thermal expansion co-efficient.

In this respect there is again a violation of the precepts in the case of chimney mortar. There we combine one part by volume of cement with two parts by volume of lime, using a mortar of only a few kilos of tensile strength, making the error of increasing the thermal expansion co-efficient by the large amount of lime used. The mortar of the necessary strength for chimney construction can be made better and for the most part cheaper from cement and "K" substances or can be built up from lime and "K" substances. I designate as "K" substances silicic acid substances, i.e. trass, Si-substance, thurament, blast furnace slag, etc., where we are certain of fully combining the lime and of producing a mortar of sufficient strength. In this place I would ask if there is any purpose in working with so large an addition of lime, inasmuch as the cement when it surrounds the lime does not allow the latter to harden through carbon dioxide absorption. Presumably we do so only in order to give the mortar a certain plasticity or in order to weaken it in strength for economic reasons. If care were taken to add to the cement, instead of lime, an amount of "K" substance equivalent to the excess of lime and to care for its combination, a better result would no doubt be obtained. That, accordingly, a road-construction concrete made from Soliditit, or from cement with an aggregate such as thurament, would have an advantage, is evident. Lime in a free state (Portland cement does not contain anything to combine with it) must, however, be avoided in road-construction concrete.

Road-construction concrete and chimney mortar can satisfy the demands of a high tensile strength with a small thermal expansion only by bearing in mind to deal with the lime question in the sense of keeping it low or the binding quality, and with the silicic acid question with a view towards a certain raising, and with regard to the aggregate the greatest lowering of the thermal expansion co-efficients, besides a high density, low porosity and a minimum of swelling and reaction with the constituents of the cement which favor swelling. These principles should be kept before the eye in the future.

To the cement investigator and technician the problem in view is: an increase in the tensile strength. The cement of the future will be the one possessing the highest tensile strength. Possibly a more intensive study of porcelain and the influence of the low atomic weight elements, such as magnesium, boron, and beryllium, in nature, as well as porcelain and artificial corundum, and other substances will indicate the course to be taken. In this field, there is, however, a certain limit which must not be exceeded. This would be a tensile strength of from 100 to 150 kg as a maximum for a pure cement of the future, which may be considered as the goal to be strived for by future research.

I have to give space here to the supposition that this is to be attained, not so much by chemical as by physical means. In reference to the latter we have to deal with the aggregates and their inner structure and the grinding of the same, which may have an influence upon the development of the physical state of the same and upon the developments of mills. Possibly it may also be feasible to increase the tensile strength of mortars by the inclusion of fibrous materials, but as long as in the case of cement we have to do with a colloidal hardening which does not lead to the production of crystalline compressed artificial stone we can not entertain any too bright hopes of achieving success.

Personally I have the idea that there will be produced magnesia Portland cements and magnesia-alumina fusion cements with a far higher tensile strength like our lime cements. It would be possible to devote oneself to the study of cements of this type for the benefit of restricted interests only. Incidentally mention can be made that a Sorel sand mortar (cement from magnesite and magnesium chloride solution) of tensile strength of from 50 to 70 kg/cm² was brought up to a tensile strength of nearly 100 kg/cm² already on the addition of 17 per cent of Si-substance.

Ten Largest Industries Determined

The ten largest manufacturing industries in the United States, measured on the basis of value of output, are revealed in the newest study of mills and factories to be completed by the U. S. Census Bureau.

The automobile industry, with an annual output at wholesale of approximately $3,372,000,000, heads the list. The slaughtering and meat packing industry ranks second with an output of $3,050,000,000. This industry long stood at the head of the list of all manufacturing lines.

Steel works and rolling mills constitute the third largest line, while in order follow petroleum refining, printing and publishing, foundries and machine shops, cotton products, electrical machinery, automobile body works and lumber and timber products plants last. The groupings are those arranged by the Census Bureau.

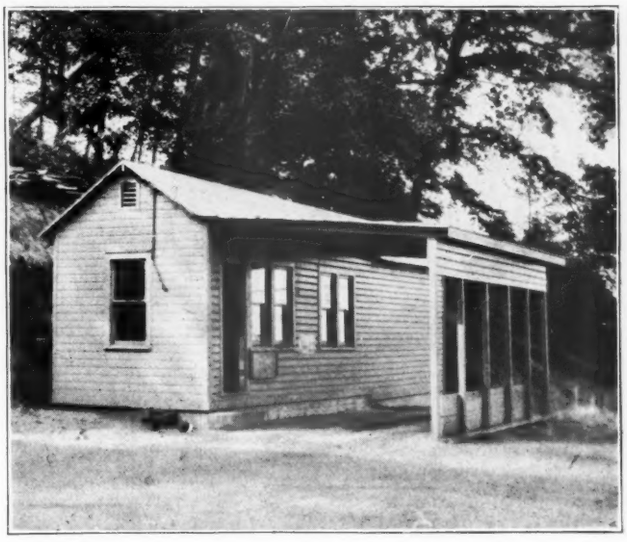
The figures quoted for output in one year are for 1925. The Census Bureau has just finished its study of manufacturing for that year and is about to begin its study of operations during 1927. No study will be made by the bureau covering manufacturing during 1926. As made by the Census Bureau, the study covers virtually all mills and factories in the United States and is more authoritative than any other similar data dealing with manufacturing. The list does not include the highway industries nor the construction industries because they are not interpreted as manufacturing industries.

LIMITED STORAGE AREA PROBLEM SOLVED BY EASTERN TRAP ROCK COMPANY

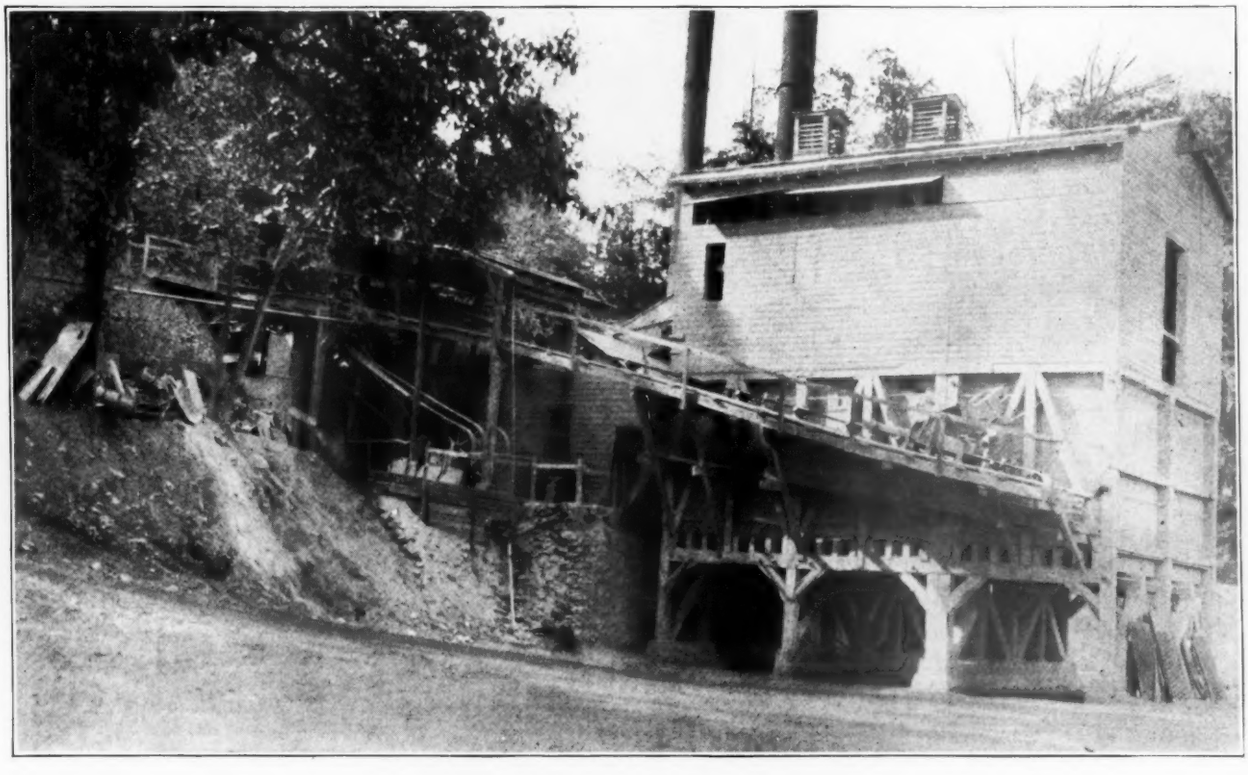
By George Ransom

TWO features are of particular interest in connection with the trap rock operation of the Union Building and Construction Company at Clifton, New Jersey. The first of these is the method for making stock piles, in the rather restricted area available for this purpose, and the second is the good balance maintained between the various processes so that a breakdown of machinery in one part of the plant will not cause a shutdown of the entire plant.

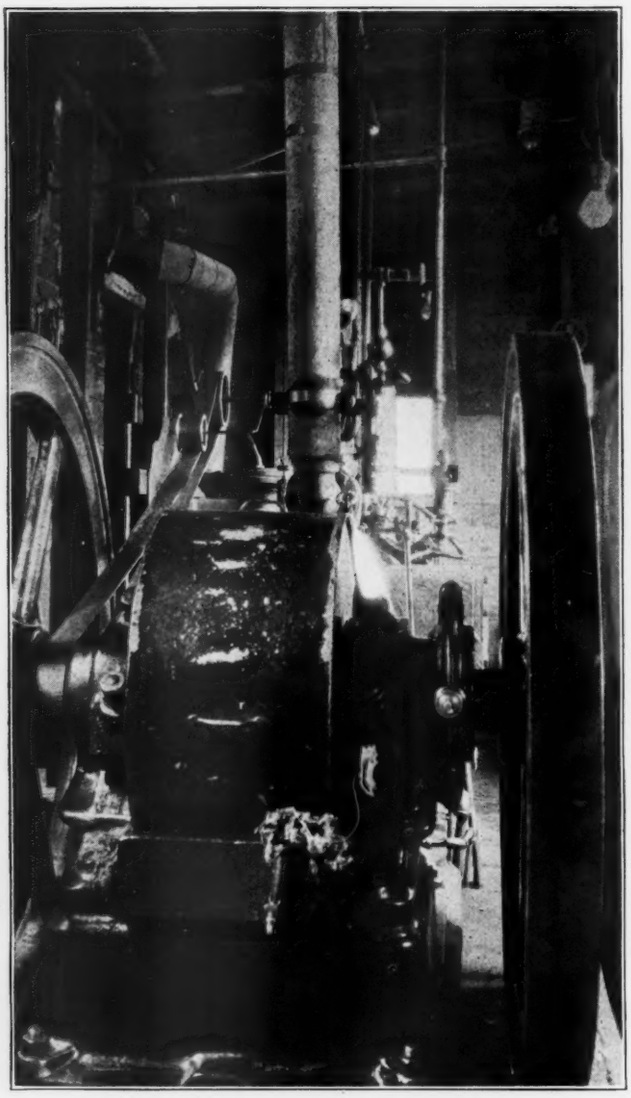
The reason why there is not much space available for stock piles at this plant is because the quarry is in the side of the mountain with the crushing plant below and a state highway at the bottom of the mountan. When crushed stone of the usual sizes accumulates beyond the capacity of the bins it is taken in trucks and dumped off a bank. In some cases these banks are partly artificial but the general slope of the land is always taken advantage of when making a stock pile. However, where the natural slope of the land is not steep enough, the stone is dumped and a pile built up along the downward slope so as to maintain a level surface, or, by means of ramps, one slightly higher to the starting point. Of course, as the truck gradually works backward, the stone becomes packed down sufficiently in the wheel tracks to support the truck. On the surface where the larger sizes of stone are it is necessary to dump a small amount of the finer sizes of stone in order to make a well-packed track. Good sized stock piles of all commercial sizes of crushed stone are maintained to take care of the changeable demands in this



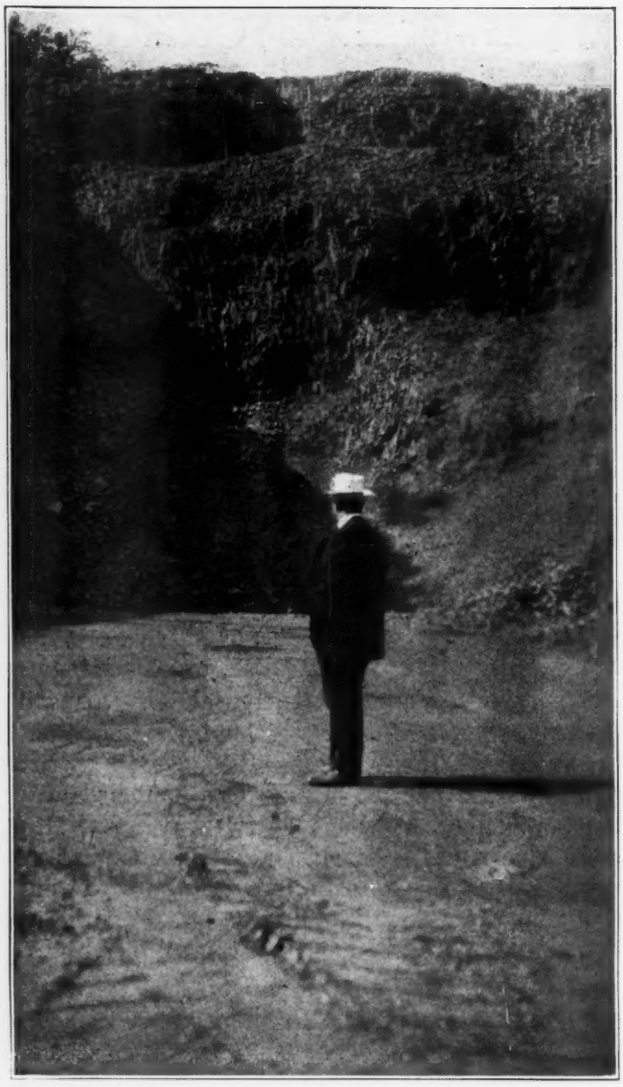
Office Building with Scale at Right



View of Crushing Plant Showing Return Conveyor from Screen to Secondary Crushers



The Steam Driven Compressor



The Breast of the Quarry. Note Extreme Cleanliness. Mr. Milloy, the Superintendent, in the Foreground

Well Arranged Stock Piles

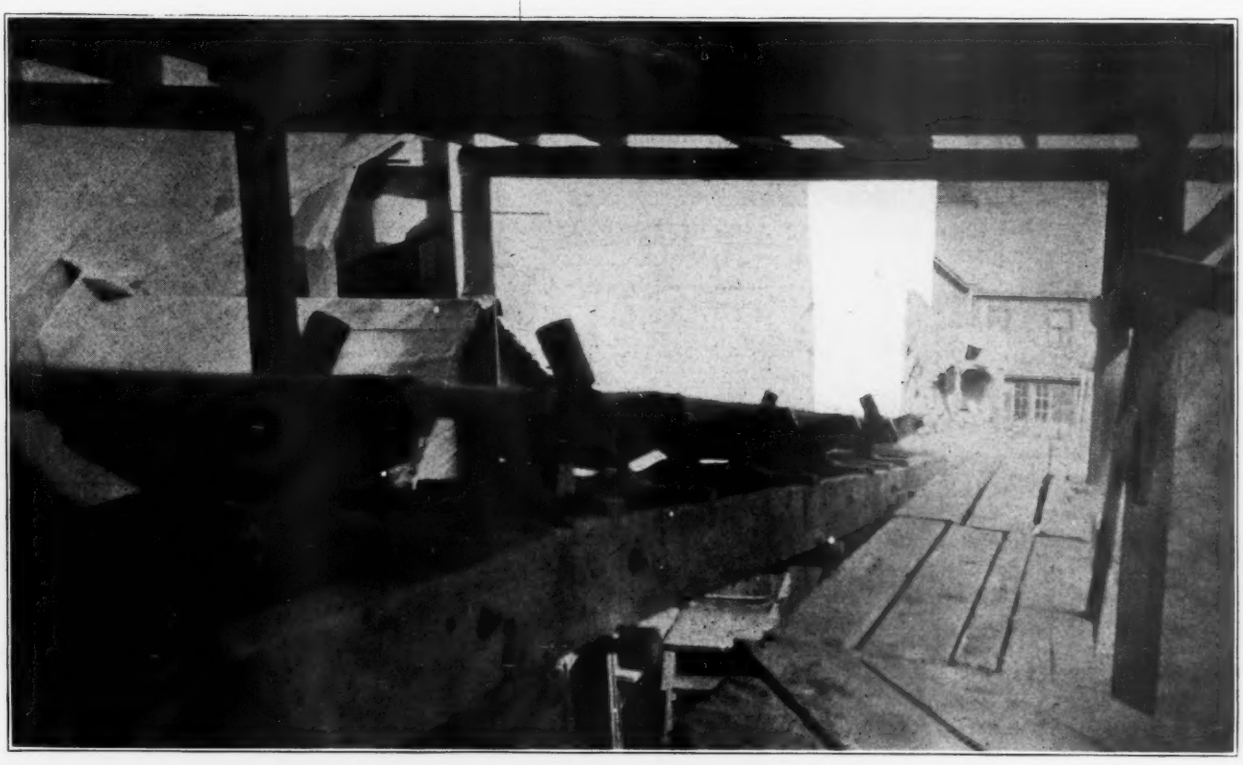
Loading a Truck from a Stock Pile

Steam Shovel Used in Quarry to Load Trucks

region. Two Haiss loaders operate at the bottom of the piles to load trucks.

The other feature of unusual interest which makes for well balanced operations is a long chute from the floor of the quarry to the crushing plant. As the stone is taken from the breast it is dumped into this chute, which when full holds enough stone to keep the crushing plant running for approximately a day. The advantages of this chute are obvious. If the shovel in the quarry breaks down the crushing plant can still keep on operating until the shovel is repaired. On the other hand if something should happen in the crushing plant, so that the machinery had to be stopped for a while, the operations do not have to be suspended because the chute can take the stone which is taken out by the shovel. Only once in the last eight years has a combination of circumstances occurred making necessary a complete shutdown of operations for any length of time.

The face of the quarry is 125 feet high in some places and to remove the rock two Wood churn drills, one Chicago drifter drill, Ingersoll-Rand and wood jack hammers are operated and the stone is taken out in benches. Holes are drilled 20 feet deep and twelve to fourteen of these holes are shot at a time, forty per cent Red Cross dynamite being used as the explosive. Of course, in a thickly inhabited region, such as this, due regard must be given to neighboring property owners. This consideration is still further carried out by working the quarry so that the outer faces are left in order to form wing walls. This helps much in protecting the neighbors from disagreeableness during the blasting operations. A Marion number 21 steam shovel with a ¾ yard dipper is used to load the



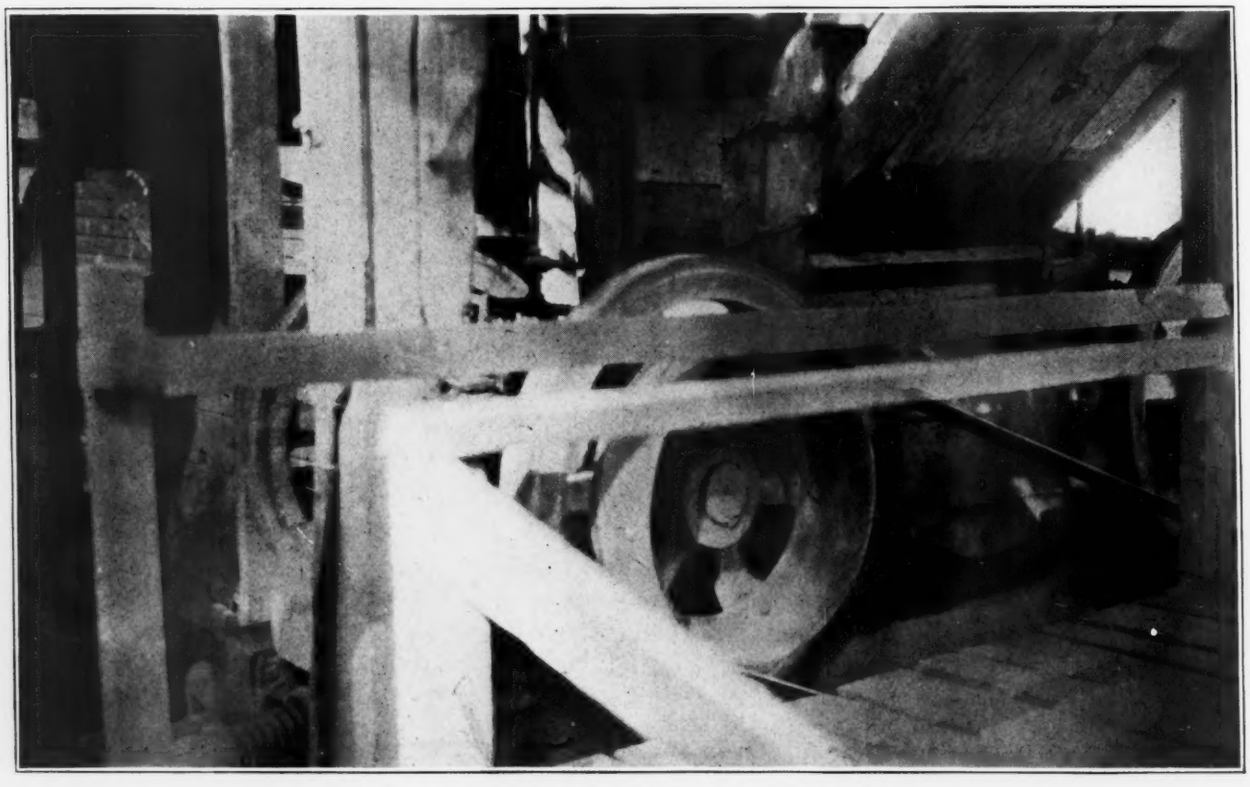
Return Belt Conveyor

Stock Pile Made on Sloping Ground. Note Ramp Built up by Dumping from Trucks and Wheel Tracks.

stone into a Selden truck which takes the stone and dumps it into the chute.

Although this truck is equipped with a hoist of its own a very ingenious device has been provided to save time in dumping. This consists of a wire rope loop on the bottom of the truck and a hook on the ground. As the truck backs to the opening of the chute the loop engages with the hook and raises the body gradually as the truck comes into position for dumping. The neatness of the quarry, and in fact all parts of the entire operation, is very conspicuous. Mr. Milloy, the superintendent, is very particular about this and feels that it is of prime importance.

The crushing plant was designed 30 years ago, long before electrical power was available, and is still steam operated. However, the reason for this is that only recently electrical power lines of sufficient capacity have been constructed near enough to be of service at the plant. Power is furnished by an Earl C. Bacon single cylinder non-condensing engine supplied with steam from a 250 h.p. Samuel Smith & Son horizontal tubular return boiler and the compressor is a steam driven Chicago Pneumatic. The primary crusher is a 13x24 Farrell jaw crusher and a Robbins belt conveyor carries the stone from the primary crusher to a revolving screen, designed by Earl C. Bacon. A conveyor



Primary Crusher at Bottom of Chute from Quarry

also designed by Bacon takes the rejects from the screen to the secondary crushers. There are two of these crushers located alongside of each other and close to the primary crusher. Both crushers are Farrell, one being a 20x6 inch and the other a 15x9 inch. The conveyor discharges into a chute which divides the flow of material between the two crushers, which in turn discharge into the conveyor from the primary crusher to the screen. The office is in a very neat small wood building at which trucks are weighed on a W. S. Meyer scale. The Union Building and Construction Company uses a large proportion of the stone on its own contracts but considerable is sold to outside contractors. Trucks are hired to convey the stone from the plant to customers.

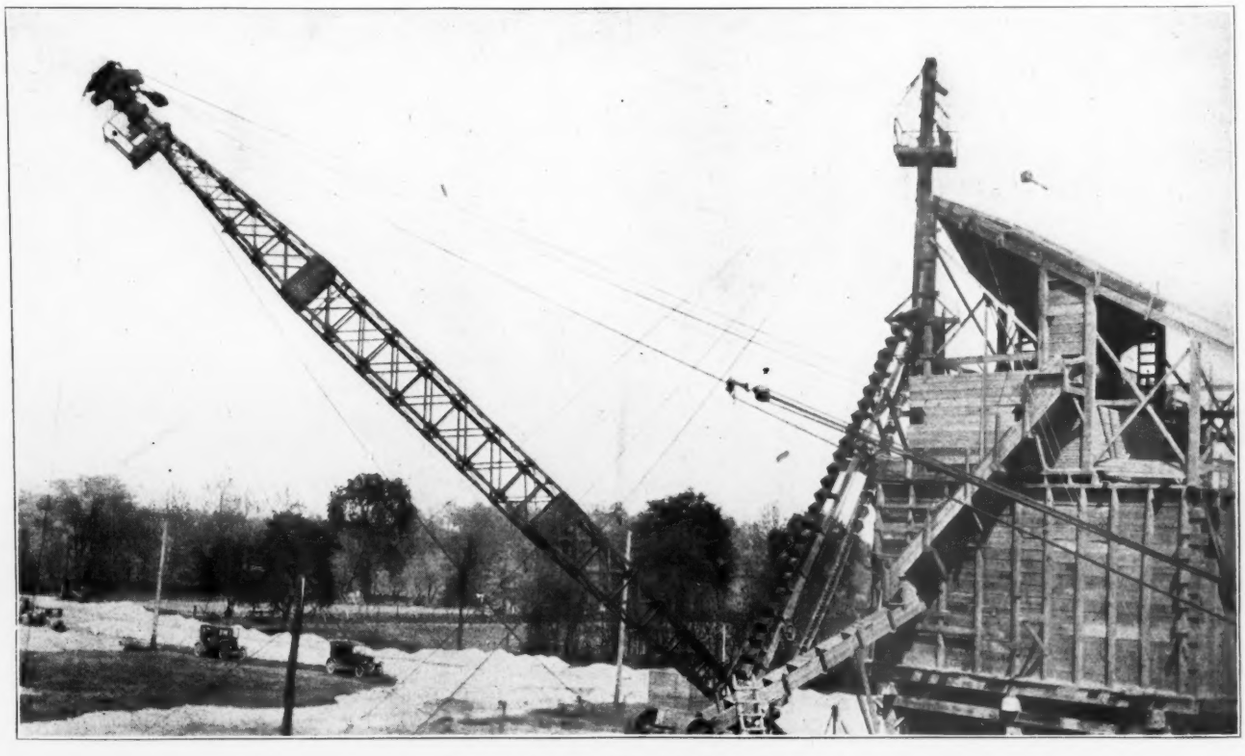
Truck Dumping Quarry Stone into Chute to Crushing Plant

GOOD CLEAN AGGREGATE KEY TO GROWTH OF OAK HILL GRAVEL COMPANY

GROWTH in the sand and gravel industry generally is the result of good management. It is true that the majority of the present large producers are the outgrowth of a smaller unit or the consolidation of units which in themselves had small beginnings. This growth comes as a result of a growing market frequently but often as a result of good management. Both factors figured in the present position of the Oak Hill Gravel Company of Springfield, Ohio, and in addition the reputation for producing a good clean aggregate.

It is only a few years ago that this company started in the sand and gravel business with a small plant. This year they placed in operation a thoroughly modern slackline cableway plant with a capacity of 40 yards per hour. While the present plant cannot be classed as a large plant it does represent a decided growth over the small beginning a few years ago. The next step will put this company among the larger single unit plants.

Clem Beals, organizer of the company, was in business with a cement products plant at Springfield. He purchased a small Sauerman scraper to excavate the sand needed in the manufacture of cement products. The machine was able to produce considerably more than was needed and at a cost

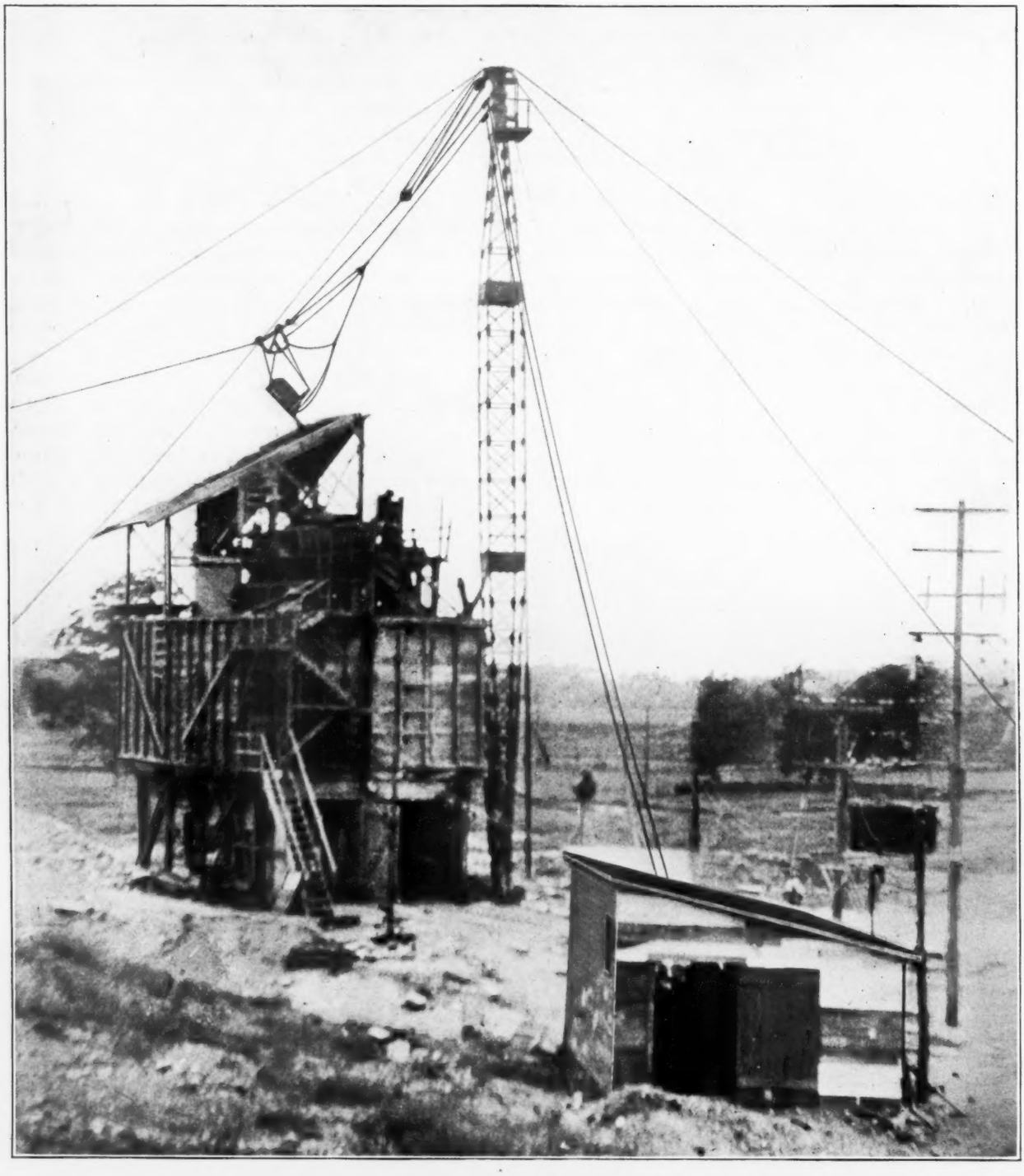


Raising the Mast For the New Plant

much less than the old method of shoveling by hand. The comparative costs and the excess capacity started Mr. Beals to investigating. He had a gravel deposit of good size; so he interviewed a number of contractors in the vicinity. A market was found to be available, so the decision was made to go into the sand and gravel business. A complete washing and screening plant and a 1/3 cubic yard Sauerman slackline cableway were installed.

Clean well graded aggregate and deliveries on schedule brought the confidence of the trade. Business was good and improving. By the latter part of 1926 the plant could not produce enough material to supply the demand. Plans were then made during the past winter for a new and larger plant. It was found that the old plant could be sold for a fair sum. Before definitely deciding to build the new plant, a number of other plants were visited and investigated. The decision was finally made to build the new plant and have it ready for business in the spring.

A 3/4 yard Sauerman cableway of the latest design was purchased and a complete Morrow washing and screening plant. Roller bearing sheaves are used throughout. A 90 foot mast and a two speed power unit were installed. The same business principles are in force and the Oak Hill Gravel Company are expecting a profitable season.



The New Plant of the Oak Hill Gravel Company

METALLURGICAL CONTROL OF FOUNDRY SANDS

By L. B. Thomas
Metallurgist, Fairbanks, Morse & Company*

MOLDING sand is a mixture of quartz or silica, clay and feldspar, with a certain amount of oxide of iron, lime, magnesia and titanium. Silica is the heat-resisting material; it contains but little if any bonding substance. Silica sand when fairly fine and tempered with water does possess a certain degree of cohesiveness, this property being largely due to surface tension. Silica alone is very refractory; but by its union with magnesia, lime and iron, silicates are formed that fuse or melt at comparatively low temperatures.

Alumina and silica unite in all proportions to form clay. Where cohesiveness is required, alumina must be present. Alumina causes the particles of sand to hold together; hence, a sand high in alumina is very refractory, but unlike silica, it is baked together like pottery at a high temperature; consequently, too much alumina must not be present in molding sand. When the bond (alumina) becomes excessive, it adheres to the castings and is carried out with the refuse sand, causing waste of new sand and increasing the cost of cleaning. The bond is a cement-like substance which by its cohesiveness ties each grain of sand more or less together without filling the interstices between the grains; thus the sand is said to be permeable to gases.

The sand, therefore, being permeable, has a permeability number corresponding to the degree of permeability to gases of the sand. This number is determined by drawing or forcing a definite quantity of air through a standard prepared specimen of sand to be tested in a specified length of time.

The soda and potash present in molding sands are combined with silica and alumina to form feldspar. Sands containing high percentages of feldspar are not very refractory and should not be used where they are subjected to high casting temperatures.

Dry molding sand when placed upon the surface of molten metal should not crack or fuse; if it does, this is an indication that feldspar is present, and the sand if used to make molds should be watched carefully, for it may cause blow holes and slaggy castings. Sands often subjected under the microscope for examination reveal high percentages of feldspar.

Lime may exist in sand as oxide, dydrate, carbonate, or sulphate, but usually as carbonate or oxide. The carbonate is the most objectionable. Most of the lime salts are converted into oxides on burning; consequently, excess of lime will cause a mold to either drop or crumble. Magnesia is very similar to lime, but less harmful, because it is more refractory. Organic matter gives bond to sand, but the bond is destroyed by the burning of the organic matter as soon as it comes in contact with molten metal, causing the sand to shrink or crumble.

In all sands high in alumina, water has entered into chemical combination with other substances; this water is known as combined water. If sand containing combined water is heated to a fairly high temperature, the water is driven off, compelling the sand to shrink. This shrinkage may cause the surface of the mold to crack.

Compounds of iron if not in excess of 4 per cent seem to be beneficial rather than detrimental. It would seem that iron compounds bear relationship to so-called "fat" and "lean" clays. A good sticky clay is called a "fat" clay, while a clay which will not stick together when wet is a poor clay or "lean" clay. If these compounds of iron be converted into ferric oxide by high temperatures and in the presence of silica, they produce slag; and the castings may show defective, due to slag inclusions.

Therefore, the three predominating constituents of mold-sand are: Clay, feldspar, and quartz (silica). Pure clay, known technically as kaolin, is a hydrated silica of alumina having the formula: $[H_2\ Al_2\ (Si0_4)_2—H_20]$. This is the basis of all clays which are designated by the following names:

Ball, pottery, pipe, stoneware, fire, flint, slip, brick, loam, marl, shale, etc. All of these clays range through all stages of impurity down to the point where the material contains but little or none of the clay base, and therefore cannot be technically classed as a clay. Table 1 gives the chemical composition of clay (kaolin), feldspar and quartz.

Table 1.

CHEMICAL COMPOSITION OF KAOLIN, FELDSPAR AND QUARTZ

	Kaolin Per Cent	Feldspar Per Cent	Quartz Per Cent
Silica	45.78	71.65	98.65
Alumina	36.46	16.10	1.09
Iron Oxide	1.36	.10	.15
Lime	.50	.20	....
Magnesia	.14	....	....
Potassium	.31	8.59	.05
Sodium	....	2.98	....
Titanium	....	.03	....
Loss on Ignition	15.45	.35	.06
	100.00	100.00	100.00

Feldspars are composed of silicate of alumina with variable amounts of potash, soda or lime, and are divided into two groups, the orthoclose and plagieclose feldspars. Feldspars are mostly clear and transparent, but sometimes they are white,

*Presented before the American Foundrymen's Association at Detroit meeting, September 27 to October 1, 1926.

flesh colored or green, and frequently they are opaque because of impurities. They have a quartz-like lustre, often slightly pearly. They are more or less fusible before the blowpipe.

Quartz (oxide of silica) occurs crystallized, usually in hexagonal prisms, with six sided pyramid for termination; also granular or compact. Quartz is an essential constituent of a variety of rocks, such as granite, gneiss, sandstone, mica-schist and quartz porphyry.

Five Important Properties of Molding Sand

There are five characteristics, namely: bond (clay), permeability, fineness, durability and refractoriness, in which we are interested because they are directly related to the workability of the sand and the quality of mold which it can produce.

Determination of Clay Substance

When we speak of "bond" we refer to the clay ontent of the sand. We are interested in the per cent of bond (clay) because this is the substance that makes for cohesiveness. We fully realize the significance attached to the word cohesiveness, for it may apply to a fine sand that has but little bond, but on account of the surface tension there is considerable cohesion. When the molder has drops or fall-outs, it is due to the percentage of clay substance, providing that the temper is right and that the mold has been properly rammed. If the clay substance is too high, then we have other complications; the mold may blow, rough surface, etc. So we deem it very important to determine the percentage of clay substance in each and every car of molding sand that enters the plant. This is not sufficient, however, to insure good castings; the sand in the heap must also be tested at regular intervals to determine the percentage of clay substance.

By determining the percentage of clay substance in the new sand as received it is therefore possible to control the heap sand by proper additions of new sand with a known clay content. Every foundry has different conditions. It has been our experience that where sand control work is adopted, it is absolutely necessary to study the existing conditions thoroughly before recommending any change in practice. Very often where one particular grade of sand has worked satisfactorily in one foundry, it does not seem to work as well in another. The quality of the sand used in each case may have been very close. We know that there is a reason for it; but you often hear that this sand or that sand does not work satisfactorily. In a case of this kind, a thorough study of foundry conditions must be made and then it is possible to draw conclusions whereby a solution to the problem is at hand.

Temperature of Iron Important

In many foundries there exist considerable differences in the temperatures of the molten iron. In some cases the coke ratio is different and even the bed is higher or lower in practically the same size cupola; that is, the amount of coke above the tuyeres varies in height. This can in most cases be easily accounted for. It is considered by the best operators (cupola) to determine the proper height the bed should be above the tuyeres, and a gauge is made so that day in and day out this proper height can be easily maintained. It is necessary, however, to make sure that the bed is properly fired when the gauge is used; otherwise the bed will be too low, the iron will be sluggish and will not run freely, due to oxidation. Although the cupola may melt quickly, the iron will be on the dull side; in some cases we have found it to be as low as 2100 degrees Fahr. Iron on the dull side will not attack the clay substance nearly as readily as the higher temperature irons with a temperature of about 2350 degrees Fahr.; up in this range it does not take much of an increase in temperature to destroy the bonding qualities of some molding sands. In many foundries, where they are using big cast scrap in their cupola and melting on a high bed, the iron melts slowly but is exceedingly hot; therefore the loss in the bond of the molding sand is greater. Depending also on the size and shape of the castings.

Sand Should Be Tempered Properly

In many foundries the sand is not properly tempered. This is especially true in foundries using the continuous pouring system. It is possible to standardize on the method of tempering sand so that at all times you can be reasonably sure that the molding sand contains a certain specified percentage of moisture. Where the sand system is of the old style, it is somewhat harder than where you have a definite amount of sand. When water is added to sand in the hot state, just after it passes over the shakeout, it is impossible to get the correct amount of water for proper temper. It is especially bad if this improperly tempered sand is used over again in twenty-five or thirty minutes while the sand is in this hot condition. Sand, carefully examined, that has been subjected to the above severe conditions, will show that some of the sand is entirely dry while other parts are exceedingly wet; also the bonding substance appears to be in little lumps, and more appears in some handfuls than others. This is a very bad condition and should be remedied at once as considerable scrap will be caused by this poor tempering of the sand. Metal may wash the dry sand particles from one part of the mold and cause a sandhole elsewhere; then, again, the metal may not lie on the particle of clay substance that has balled up, causing a blowhole.

The best condition for sand tempering is where the sand is allowed to remain in a hopper or bin for at least 24 hours. This will cause the sand to mellow and it will be sufficiently cool to insure the best casting and molding condition. Some sands take more water than others when tempering; this condition is caused by the bonding substance. Just sufficient water must be added to bring back the life of the clay.

By this statement we do not mean that a sand that has been burnt, the silica that was formed by the heat, can be brought back to its original state of plasticity, the hydrated aluminum silicate, but we do mean that the large bulk of the original silicate must have sufficient water added to insure its maximum degree of cohesiveness. This moisture in sand can be easily determined once the temper is correct for that particular grade of molding sand.

In a molding sand containing approximately 25 per cent clay substance we have found that a moisture content of between 7 to 7.5 per cent works very satisfactorily. We have used a rather crude method for the determination of moisture in molding sands, but it is believed to be accurate enough for foundry control work.

A sample of sand is taken every hour and sent to the foundry sand control room, usually a small room in the foundry that has been turned over to the man in charge of sand testing. To do this work in the chemical laboratory causes more or less friction with the analyst. He will insist that you are getting sand all over the place. Careful as you may be, he will tell you that sand is getting into some of his beakers or flasks and spoiling his determinations. So we have found that the best place for making sand control determinations is in a separate room, especially fitted for this phase of sand testing work.

It has been our practice to take 25 grams of the thoroughly mixed sample of sand to be tested for moisture, received in a glass stoppered bottle, and put it in an evaporating dish for about 10 minutes on a gas hot plate, weighing to constant weight. This has been sufficiently accurate to enable us to keep check on the moisture content of our foundry sands.

Determination of Clay Substance

The method used in determining the clay substance in molding sand is described in detail later. A good molding sand that can be used for general molding must contain at least 20 per cent clay and in most cases can run as high as 30 per cent for maximum clay content.

The one big factor to bear in mind is uniformity of clay content in subsequent shipments. One carload must not be on the low side and the next carload on the high side. It is possible to maintain a uniform product that will not vary more than 1 or 2 per cent in clay substance.

Permeability Number of Molding Sands

Our tests have all been conducted with a special vent meter, which a sand producing company has placed on the market. This apparatus, together with detailed methods of operation, is described later.

Determination of Fineness

Fineness of sand is determined by sifting 50 grams of dried sand through a nest of sieves; namely, No. 20, 40, 60, 80, 100, 150 and 200 mesh.

The sample is placed on a No. 20 mesh sieve and lightly rubbed with a No. 7 rubber stopper, holding the large end of the rubber stopper in the hand. After sifting on the 20 mesh for two or three minutes, the sand retained on the 20 mesh sieve is carefully weighed and reported as such. The 20 mesh sieve is put to one side, and the process repeated on all the other sieves. This is reported as fineness of sand containing clay substance (see Tables 2 and 3). A fineness determination is also made on the sand after the clay substance is removed. A careful study of the fineness tables will show how the grain size is affected before and after removal of the clay substance.

Table 2.

FINENESS TEST OF MOLDING SANDS CONTAINING CLAY BOND

Name of Sand	Per Cent Caught on No. 20	Per Cent Caught on No. 40	Per Cent Caught on No. 60	Per Cent Caught on No. 100	Per Cent Caught on No. 150	Per Cent Through No. 150
D—No. 5	0.00	14.80	23.20	29.20	4.20	27.80
D—No. 7	0.00	11.20	13.40	52.40	10.00	12.60
*D—No. 7	1.80	15.60	14.20	40.60	12.20	15.60
D—No. 7-A	0.00	1.80	6.80	59.00	11.60	20.80
G—No. 4	0.00	27.20	28.20	26.20	5.60	12.80
*G—No. 4	.20	37.74	29.38	20.60	4.08	7.96
G—No. 4-A	.20	31.40	23.00	22.60	5.80	17.00
*G—No. 4-A	.20	28.00	24.40	22.80	4.80	19.80
H—No. 2	.20	11.80	15.60	39.20	14.60	18.20
*H—No. 2	.20	20.00	22.20	40.60	8.00	9.00
H—No. 2-A	.40	8.20	14.20	40.40	13.40	23.40
*H—No. 2-A	.20	8.20	15.00	39.20	11.40	26.00
Hu—No. 2	0.00	2.40	9.40	33.60	30.20	34.40
*Hu—No. 2	.07	9.50	13.40	36.00	9.90	29.60
Hu—No. 2-A	0.00	1.60	6.60	37.00	22.80	32.00
*Hu—No. 2-A	1.20	4.00	8.60	27.60	21.20	37.40
Hu—No. 4	.40	36.60	21.40	23.60	6.20	11.80
*Hu—No. 4	0.00	24.00	20.60	27.40	6.20	21.20
WP—No. 1	.40	12.00	15.20	33.40	14.00	25.00
WP—No. 1-A	.20	11.40	19.60	24.60	12.00	16.20
*WP—No. 1-A	.70	2.90	10.50	49.60	10.80	24.00
WP—No. 2	.20	3.20	9.40	36.40	18.60	32.20

*Burnt.

Table 3.

FINENESS TEST OF MOLDING SANDS WITH CLAY CONTENT REMOVED

Name of Sand	Per Cent Caught on No. 20	Per Cent Caught on No. 40	Per Cent Caught on No. 60	Per Cent Caught on No. 100	Per Cent Caught on No. 150	Per Cent Through No. 150
D—No. 5	0.00	17.65	26.75	26.75	5.51	23.45
D—No. 7	0.00	13.27	12.56	48.50	11.87	14.00
*D—No. 7	.85	16.17	14.45	41.10	12.98	14.46
D—No. 7-A	0.00	13.00	13.50	50.00	10.50	13.00
G—No. 4	0.00	19.90	26.85	31.65	6.54	15.10
*G—No. 4	2.00	37.10	25.80	20.90	5.12	9.12
G—No. 4-A	.34	32.64	23.80	25.26	5.70	12.36
*G—No. 4-A	.05	32.00	24.55	23.70	5.45	14.15
H—No. 2	.78	8.41	13.41	38.90	15.10	23.45
*H—No. 2	1.75	13.75	17.75	36.50	11.25	19.00
H—No. 2-A	.37	8.52	14.62	38.02	13.57	25.00
Hu—No. 2	.55	1.93	6.34	32.23	21.21	37.74
*Hu—No. 2	.89	14.80	17.00	30.70	11.62	25.00
Hu—No. 2-A	0.00	1.30	6.00	32.00	19.30	41.40
*Hu—No. 2-A	3.02	6.75	9.53	30.95	16.50	33.25
Hu—No. 4	0.00	34.51	21.70	23.51	6.62	13.41
*Hu—No. 4	.22	37.45	21.15	23.45	5.45	12.30
WP—No. 1	.23	15.35	17.68	32.10	12.55	22.08
WP—No. 1-A	.23	15.60	17.70	32.80	13.27	21.40
WP—No. 2	2.50	3.75	10.68	34.75	15.30	35.25

*Burnt.

Wherever possible, sieves of the following sizes should be adopted, namely—Nos. 6, 12, 20, 40, 70,

100, 140, 200 and 270. This standard set of sieves has been recommended* by the American Foundrymen's Association. In many foundries where sand control work is being carried on, the only sieves available for fineness tests are ones that have been discarded by the chemical laboratory. These are not always satisfactory, due in many cases to a large jump in sizes between certain sieves in a range where a small variation in grain size means much to the surface of the finished casting.

Table 4.

FINENESS OF FOUNDRY SANDS

Grade		Fineness Factor
No. 0	Superfine	Above 100
No. 1	Fine	95 to 100
No. 2	Medium Fine	85 to 95
No. 3	Medium	75 to 85
No. 4	Medium Coarse	60 to 75
No. 5	Coarse	45 to 60
No. 6	Extra Coarse	25 to 45

EXAMPLE OF CALCULATION* OF FINENESS FACTOR

Weight of Sand Passing Through Sieves, in Ounces		Number of Mesh of Sieves Used		
55.22	×	100	=	5,522.00
20.89	×	80	=	1,671.00
11.64	×	60	=	698.40
10.57	×	40	=	422.80
1.20	×	20	=	24.00
.06	×	1	=	.06
.42	×	60	=	25.20
100.00				8,363.66

$\frac{8363.66}{100}$ = 83.64 Fineness.factor

Sand with a 83.64 Fineness factor would be classed as a No. 3 Medium, nearly a No. 2 medium fine. Any loss is credited to the 60-mesh sieve. Any sand that does not go through the 20-mesh sieve is credited to the 1-mesh sieve.

*International Correspondence Schools, Green Sand Molding, Part 3, 1699-C.

If the finish of castings is to mean much in the foundry industry, more care will have to be taken in making the fineness test. It is recommended that a mechanical sieve shaker, the use of which may yield identical results, be used when making fineness determinations.

Purchasing Sand by Designated Number

Before long every sand will be designated not only by a grade number for fineness but also by a class distinction for chemical and physical characteristics. Some sands have been tested by dealers for the degree of fineness. The degree of fineness of their respective sands determined, they have divided them into seven grades, according to their fineness as shown in Table 4.

Size and Shape of Sand Grains

As a general rule the smaller the grain, the finer the surface of the casting. In casting heavy masses of iron, a mold of very fine sand will not take off the gases fast enough once they can no longer escape through the risers; therefore, the necessity of making tests to determine a sand that will produce a good smooth surface consistent with proper venting qualities. If the matter is complicated by angularity on the part of the grains, it is very easy to see that too hard ramming can quickly spoil a mold made of sharp molding sand, while the rounder grained varieties are not in such danger.

Within the last few years, competition between the large manufacturers has done much to improve the poor surface and appearance of American made castings. Paint heretofore covered a multitude of sins; but since the larger foundries have adopted a rigid method of inspecting castings in the rough the general appearance as well as the quality has been raised to a higher plane, although we have not given the sand problem as much attention as the European foundrymen.

The Belgian foundrymen are noted for their magnificent work the world over. The sand used is highly expensive and is looked after most carefully. The foundrymen of France, Germany and England pay special attention to the preparation of sand with consequent good results.

Durability and Refractoriness

One sand is said to be more durable than another, to possess greater refractoriness, when it stands up longer in the heap without showing signs of going to ashes, although the clay content, permeability, and fineness are practically the same in each case.

We make a shop test on the first carload of every new grade of sand received. In addition to this shop test we conduct a severe burning out test, using some simple pattern with no core work. It is possible to make a very satisfactory shop test when conditions are such as to permit the use of new sand additions to conveyors where the sand is used with jar-squeeze-draw molding machines, especially when using the continuous pouring system and one grade of iron day in and day out, making a uniform size casting with standard steel flask equipment.

Table 5.

CHEMICAL AND PHYSICAL DATA OF SANDS R R S and W M S BEFORE BURNING OUT TESTS WERE CONDUCTED

A—Chemical Analysis	Sand R R S per cent	Sand W M S per cent
Loss on Ignition	3.44	3.06
Silica	79.45	80.16
Alumina	9.65	9.66
Iron oxide	4.11	3.79
Titania	.48	.22
Lime	1.00	.63
Magnesia	.24	.17
Manganese	.01	.01
Oxide of Potassium	1.25	1.12
Oxide of Sodium	.81	.59
B—Rational Analysis		
Quartz	62.73	64.26
Feldspar	12.24	10.15
Clay substance	18.80	19.76
C—Smith Vibrator Test*		
Clay substance	45.00	48.00
Silica	55.00	52.00

*E. W. Smith, Trans. American Foundrymen's Association, vol. 31, 1924, pp. 623-630.

Where the sand handling installations are large, it is nearly impossible to obtain accurate results with one carload of molding sand. It may take six or eight loads and as many weeks to determine the several characteristics of a good molding sand in a large installation, Therefore, it is advisable to conduct similar tests on a much smaller scale.

It is also interesting to note that, although two molding sands having similar characteristics will stand up equally as well under the fire test when using a sand ratio of 3.0 parts of sand to 1 part iron, by weight, yet where the inverse ratio is in

*Transactions American Foundrymen's Association, vol. 31, pp. 722-725, 1924.

Table 6.

A

Fineness Test of Sand Containing Clay Substance Purchased as No. 4 Molding Sand

	R R S per cent	W M S per cent
Caught on 20 mesh sieve	00.60	2.00
Caught on 40 mesh sieve	.80	10.00
Caught on 60 mesh sieve	3.00	25.60
Caught on 100 mesh sieve	18.80	21.20
Caught on 150 mesh sieve	21.80	4.60
Through a 150 mesh sieve	55.00	36.60

B

Fineness Test of Sand with Clay Substance Removed

	R R S per cent	W M S per cent
Caught on 20 mesh sieve	1.40	2.00
Caught on 40 mesh sieve	.80	14.00
Caught on 60 mesh sieve	4.30	24.00
Caught on 100 mesh sieve	19.80	22.85
Caught on 150 mesh sieve	24.30	5.51
Through a 150 mesh sieve	49.40	32.00

effect, i. e., where the casting weighs more than the sand in the mold, one sand will burn out more rapidly than another. We will try to explain this condition later on in the text. This will be explained by a study of Table 5, which gives results of sand control tests of two sands, R R S and W M S, both purchased as No. 4 sands. Table 5A lists the chemical analyses of the two sands, 5B the rational analyses and 5C the Smith vibratory bond test results.

The clay bond and silica per cents as determined by the method described in Appendix A are as follows:

	Per Cent in Sample RRS	Per Cent in Sample WMS
Clay substance . .	29.0	29.0
Silica (by difference)	71.0	71.0

The author has found this method very reliable when using both caustic soda and tannic acid. The fineness tests of these two sands containing clay substance are reported in Table 6A and the fineness tests of the sands with the clay substance removed are reported in Table 6B.

Although these two sands were purchased on the open market for a No. 4 molding sand, it can be readily seen from the data of Table 6 that one is finer grained than the other. Table 7 gives the permeability figures for the two sands before the burning out test was conducted. The first burning out test was made by making molds in a flask 19 inches square with a 51-inch cope and a 6-inch drag. The casting was that of a piston weighing 86 pounds. The mold and casting data are given in Table 8.

The iron was poured from the same stock ladle into a 140 pound shank. Two molds of each sand made, one time pouring one mold containing the special sand from the shank first and then alternating. Temperatures were checked with an optical pyrometer.

After molds were cast, they were allowed to remain until the castings could be handled with the bare hands. The sand adhering to the castings was scraped off and tempered well with water. Both castings were satisfactory from each mold; the appearance of the one made with WMS sand was slightly better.

Following the casting of the piston in the two sands, a clay substance determination was made after the first burning. These determinations gave the following results:

	Per Cent in Sample RRS	Per Cent in Sample WMS
Clay substance	21.8	21.6
Silica	78.2	78.4

The permeability data of the sands after the first burning are given in Table 9. The second burning out test was made by using an open top flask 26 inches by 13 inches with a depth of 9 inches. A chill mold was cast in this flask, using first one sand, then the other, the chill mold being 20 inches by 11 inches by 6 inches deep. The weight of the chill mold was 259.50 pounds, its volume being 997 cubic inches compared with 2045 cubic inches of sand used.

Table 7.

PERMEABILITY OF ORIGINAL SANDS USING VENT METER

Sample	Moisture, per cent	Cm. Vacuum	Time, seconds	Weight, grams	Permeability No.
R R S	9.00	6.5	26	170	44.5
"	10.50	8.5	30	175	29.6
"	7.50	5.5	23.5	168	58.3
W M S	9.00	7.5	24	175	41.8
"	10.50	7.5	28	175	35.8
"	7.50	5.0	23	170	65.8

Table 8.

BURNING OUT TEST No. 1 MOLD AND CASTING DATA

Volume of Sand Used per Flask (cubic feet)	2.298
Specific Gravity of Sand, approximately	1.85–2.00
Pounds of Sand per Cubic Inch	.0665
Pounds per Cubic Foot of Sand	115.00
Pounds of Sand in Flask (19"x19"x11")	265.00
Weight of Casting (pounds)	86.00
Specific Gravity of Cast Iron	7.20
Weight per Cubic Inch of Cast Iron (pounds)	.260
Weight per Cubic Foot of Cast Iron (pounds)	450.00
Volume of Metal in Flask.....(cubic inches) 330; (cubic feet)	.1911

Table 9.

PERMEABILITY OF SANDS AFTER BURNING OUT TEST NO. 1 USING VENT METER

Sample	Moisture, per cent	Cm. Vacuum	Time, seconds	Weight, grams	Permeability No.
R R S	9.00	7.00	27	170	39.7
"	10.50	10.00	32	178	23.5
"	7.50	7.50	24	170	41.8
W M S	9.00	4.00	23	175	81.7
"	10.50	4.50	24	180	69.7
"	7.50	3.50	22	175	97.6

Table 10.

PERMEABILITY AFTER BURNING OUT TEST No. 2 USING VENT METER

Sample	Moisture, per cent	Cm. Vacuum	Time, seconds	Weight, grams	Permeability No.
R R S	9.00	6.50	26	170	44.6
"	10.50	7.00	27	175	39.8
"	7.50	6.25	26	168	46.1
W M S	9.00	4.00	23	170	81.7
"	10.50	3.50	22	175	97.6
"	7.50	4.00	23	172	81.7

Following the casting of the chill mold, clay substance determinations were made of the two sands. The resulting data were:

	Per Cent in Sample RRS	Per Cent in Sample WMS
Clay substance....	16.0	20.00
Silica	84.0	80.00

The permeability test gave the results listed in Table 10.

Summary of Results of Tests

As was stated in the beginning of this brief outline, we do not feel a sufficiently exhaustive study of the various problems has been made at this writing to arrive at any positive conclusions, nevertheless,

a careful examination of the foregoing seems to bring out certain relations which may or may not hold true at all times, but which are, nevertheless, of interest, and may serve to stimulate further study in this direction.

The salient points, therefore, are enumerated in the following general summary:

1. Moisture plays a vital part in comparing the properties of sand, and never should be omitted when reporting comparative tests.
2. Chemical analysis should be made on sands about to be adopted as standards, as very often it is found by determination to contain harmful amounts of iron, lime, magnesia, sodium and potassium.
3. Each carload shipment of sand should be tested for bond (clay substance), permeability and fineness.
4. The amount of the bonding material and the colloidal condition of this material are the important factors in the life of molding sands.
5. As a rule the permeability number of a sand increases with each heat treatment of the sand.
6. The suggested casting method of testing the life of the sand closely approaches foundry practice and is considered the best means of determining the comparative durability.
7. Proper methods should be used to insure a uniform temper of the sand.
8. The balling-up of the clay substance should be eliminated by the use of a fine water spray and the rejection of any reciprocating conveyors.
9. The best results will be obtained with a sand that has been given sufficient time to mellow, and it must not be worked while hot and steamy.
10. It is to the interest of the foundry industry as a whole to find out the durabilities of the sands in common use throughout the United States.

With the above thought in the mind of the reader, it is hoped that this brief resumé of work thus far accomplished may contribute something in thought, or actual information, of value to the extensive work now being carried on by the American Foundrymen's Association committee on molding sands, and to such foundries as are engaged in similar work; and that it will point out to others the vital importance of the great problem of the foundry today.

Clay Substance Determination—Shop Control Method

Fifty grams of sand, dried thoroughly at a temperature of about 105 degrees Cent., are put into a 500 c.c. Erlenmeyer flask, and about 250 c.c. water added. The flask is well stoppered and contents shaken for several minutes. The flask is opened, and a stick of sodium hydroxide about 1¼ inch in length is added, the flask is again stoppered and contents well shaken. After shaking the contents of the flask for at least five minutes, the stopper is removed and the sides of the flask washed down with a stream of water. After sufficient time has elapsed to allow the particles of sand (silica) to settle to the bottom of the flask (usually five minutes is sufficient), the colloidal material present, together with any other hydrated minerals which impart to the sand a gelatinous and sticky constituent known as clay substance, is siphoned off, taking care that the grains of sand (silica) in the bottom of the flask are not disturbed.

The process of 5 minutes standing and siphoning is repeated until all the alkali (sodium hydroxide) has been removed by repeated washings. The sand, etc., remaining in the flask is again treated the same as above outlined with one exception, i. e., tannic acid is added in place of sodium hydroxide. One spoonful of dry tannic acid is added to the flask together with 250 c.c. of water and the process of 5 minutes standing and siphoning is repeated until the water remains clear at the end of the five minute period. By this process the clay substance is separated from the grain.

The grains of sand remaining in the flask are washed onto a filter-paper, in a 9 cm. glass funnel and allowed to drain. They are then transferred together with the filter-paper to an evaporating dish and thoroughly dried on a steam plate (bath). When dry, the sand adhering to the filter-paper is brushed off into the evaporating dish containing the bulk of the sand grains.

The difference in weight between the original sample of 50 grams and the weight of the dried grain multiplied by 2×100 equals the per cent of clay substance in the sand.

100.00 per cent—the per cent of silica grain, equals the per cent of clay substance in the molding sand.

Example:

50.00 grams (sample) molding sand taken.

40.00 grams equals weight of silica grains retained on paper. Difference:

10.00 grams = weight of clay substance removed.

2×10.00 grams = 20.00 grams clay substance per 100 grams of sand. $\frac{20.00}{100} \times 100 = 20.00$ per cent clay substance in the molding sand.

Vent Meter Method of Determining Permeability

Heap or facing sand is tested as tempered for the molders. Obtain a good representative sample by taking small portions from different parts of the heap. Put this sample, at once, into a two quart pail with close fitting top. Put the top on so as to prevent sand from drying out. Pass the sample

twice through a riddle, preferably a No. 8, and return to the pail, replacing the cover.

Next place pedestal Y on the table and put tube A down over it. Transfer about 160 grams of sand from the pail to tube A by means of the larger tin scoop received in vent meter box. The sand is placed in this scoop, the scoop held in the left hand in an inclined position over tube A and sand raked from scoop to tube A in a uniform stream and not in chunks. Do not let the scoop touch or jar tube A during the operation. Smooth off the upper surface of sand in tube so that it will be level.

Next lift the rammer head V and place tube A with its pedestal in the rammer. Lower rammer head X on sand gently, at the same time adjusting position of tube so that the head slides in the tube without binding.

Place finger of left hand on top of rod above W just enough to prevent from lifting. Raise weight V till it touches stop U and let it drop. Repeat this drop again and again until the weight has dropped three (3) times in all.

Now in order that all your tests be comparative and under the same conditions the length of rammed column should be 2 inches plus or minus 4 per cent. If, by sighting along the top of the support A-1 you are within the three tolerance limits on gauge W the sample is ready for test. If too short, knock out the sample and ram up a new one, using more sand this time and vice versa. A small balance for weighing the sand will be of good use, so you can increase or decrease the quantity, if you are making many tests.

Note: It is advisable to support the rammer on a cast iron block weighing at least 75 pounds in order to get the anvil effect.

The above operation of ramming should require not more than two minutes.

Next lift rammer to clear tube A, remove tube from the pedestal, insert rubber stopper B in end of tube, place the tube in vent meter as shown on blue print, connecting to tube D by rubber connection C. (If the tube D is moistened a little with water the rubber connections slip on more easily.)

Permeability by the Pressure Method

Close valve E and open valve F. Place finger over discharge outlets S-1 and turn on water so as to fill tube K through inlet Q, filling slowly and stopping when reservoir is just short of full, as shown on water gauge J. Shut off faucet tight, close valve F and remove finger from discharge outlet S-1. Then open valve E and watch manometer I. The water level in the right leg of the U tube will rise; note this level is indicated on the scale. The tighter or less permeable the sand is, the higher the water level will go and vice versa. The reading on the scale thus obtained is a measure of the permeability of the sand by the pressure method and is good for the daily checking of sand heaps.

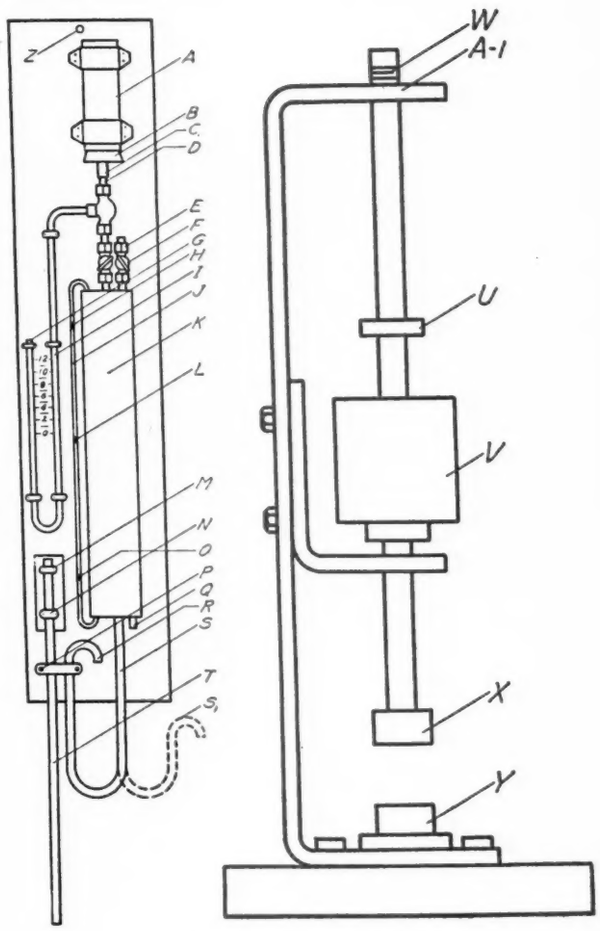


Figure One—Vent Method

Permeability by the Formula Method

This method is slower than the pressure method but should be used when comparing results with other outside concerns. Connect the rubber tube with its curved discharge to outlet S-1, as shown in the dotted lines on blue-print. Also fasten rod T in holders M and N as shown. Then proceed as in the pressure method, regulate the pressure on U tube by moving discharge up or down on rod T until the water level is exactly on one of the pressure lines of the scale. Then measure the time required for the water level in gauge I to drop from the starting point H to end point L; a stop watch graduated in minutes and tenths is advisable.

The venting power or permeability of the sand is then calculated by multiplying the time in minutes and tenths of minutes by the pressure used and dividing this product into 125.3.

The formula: $\frac{125.3}{T\ P}$, where T is time in minutes and tenths of minutes, and P is the pressure in cm. of water as shown on the manometer I.

For very open sands a pressure of 1 or 2 is best to use, while for very tight sands the pressure can be carried as high as 30 or more. The above

test can be made in two minutes. Always check the zero on manometer I before starting test and before connecting up tube A.

To Test New Sands

In order to accurately determine the venting power or permeability of new sand it is best to dry out a good representative sample and divide into several portions. Temper each portion to a different degree, depending whether the sand is heavily bonded or lightly bonded. After tempering, riddle once through a No. 8 (use a No. 4, if gravelly sands are used), place in a pail, put cover on tight and let stand for a few hours in a pail to equalize the temper. Then test as directed for heap sands.

This test will show how much the sand closes up with excessive temper and will show at what temper it has the most open structure after ramming.

For lightly bonded sands it is well to temper different portions to 6, 8, 10 and 13 per cent moisture, respectively, while for heavily bonded sands, 8, 10, 12 and 14 per cent is recommended. For tempering in this way we recommend the use of an inexpensive trip balance with set of metric weights for weighing the dry portions and a glass tube graduated in metric system for accurately measuring the tempering water to any percentage desired.

Belgium Uses Variety of Materials in Road Building

Road surfacing in Belgium since 1918 involved the use of a variety of materials. On state roads 11.326 kilometers of asphalt blocks, 30.102 kilometers of tramac, 40.719 kilometers of concrete, and 28.175 kilometers of asphaltic concrete macadam were used. On provincial roads, the provinces used the following: East Flanders, 450 meters of reinforced concrete, 400 m. of rhoubenite, 100 m. of chappat, and 50 m. of gilly bricks; Brabant, 5.876 kilometers of rhoubenite, 838 meters of asphalt blocks (wood), and 884 m. of soliditit; Antwerp, 14.8 kilometers of asphalt blocks on concrete base, 2 kilometers of asphalt "bitume" on base of broken brick, and 1 kilometer of paving blocks with asphalt filler; Hainault, 500 meters of asphalt blocks; Liege, 400 meters of soliditit and 600 meters of rhoubenite. The materials laid in lengths of less than 600 meters were put down as trials.

Every P. & Q. Handbook Valuable

Raymond J. Schirm, general manager, Mission Lime Products Company, San Diego, California, writes: "I have been receiving your 'Handbook' since it was first published in 1923 and would appreciate being retained on the list, as I find it very valuable. . . ."

Develop Shellac Creosote Cement

Several months ago an announcement was made concerning a new cement developed by the British Scientific Instrument Research Association. The new product has been investigated and it has been found that this particular cement was developed in the laboratories of the above named association with a view to producing a material less brittle than shellac, and which would be more adhesive and free from the disadvantage of tending to become fusible by repeated heating. The formula for the cement is reported to be as follows:

Shellac (preferably a good quality, such as bright orange shellac)	50 parts by weight
Wood creosote	5 parts by weight
Terpineol	2 parts by weight
Ammonia (sp. gr. 0.880)	1 part by weight

The cement is prepared by adding the ammonia, terpineol and creosote to the shellac and heating gently until completely fused, stirring well to ensure homogeneity. It is claimed that the fused mass can be poured into molds to form rods of suitable size. It is stated that the product can be readily fused for use when required for making joints between metal, glass, and many other materials which are not altered when gently heated. The surfaces to be joined should, of course, be perfectly clean, and should be warmed before applying the cement.

Bank Deposits Growing Rapidly

The relative turnover of each state in the business of banking is revealed by a report compiled by the Federal Reserve Board showing the total of deposits in all banks of every state. The report includes state banks as well as national banks and is virtually complete except for a few private banks which are not under state supervision. To avoid duplication, deposits from one bank to another are excluded.

New York leads all other states with deposits totaling $13,214,000,000. Pennsylvania ranks second with deposits of $4,694,000,000 while Massachusetts is third with $3,481,000,000. Illinois is close behind Massachusetts with deposits totaling $3,394,000,000 and then comes California, ranking fifth, with deposits of $3,126,000,000. Ohio ranks sixth and New Jersey seventh. Michigan is eighth, Missouri ninth and Connecticut tenth. The total of deposits is less than $1,000,000,000 in all other states.

The total for all states is $50,006,000,000. Deposits of the entire country are growing at the rate of approximately $625,000,000 a year. State banks reported deposits of approximately $31,992,000,000 of the total reported for all classes of banks for the entire country.

CRUSHERS AND THEIR COMPONENT PARTS

By Wm. T. W. Miller

Part II

PART one of this series of twelve articles appeared in the July number. The remaining ten articles will appear in the next ten consecutive numbers. Mechanisms applied to jaw crushers was the main theme of Part I. A careful study of the various mechanisms for applying the force to the swing jaw was presented. The efficiency of the various systems was compared and some of the defects inherent to certain designs were pointed out. Twenty-four drawings accompanied the text to illustrate the points of discussion.

Mr. Miller, the author of this series, has had thirty years' experience as a specialist in crushing machinery. For the last twenty-six years he has been employed by Hadfields, Ltd., of Sheffield, England. For the past eighteen years he has been engineer-in-charge of their crushing machinery department. He has studied crushing problems in the United States, Canada, Brazil, Uruguay, Argentine, France, Spain and Portugal.—Editor.

Jaws and Cheek Plates for Rock Crushers

The expense of replacement of the crushing faces is usually found to be one of the principal items in the cost of maintenance for any jaw crusher and, the more abrasive the stone or ore being crushed, the more serious becomes the charge against the machine.

It is surprising how many users accept the standard jaws as supplied with the crusher without considering their practical utility for their own particular purpose or their special suitability for the rock which they may have to treat.

The design of the jaws which are fitted in breakers made in stock sizes must be suitable for a great variety of materials and purposes and will, of necessity, include teeth or corrugations of a fair average section.

The superintendents in many quarries making a specialty of preparing cubical macadam, have carefully studied the shape and spacing of the teeth to arrive at a design which will give the best results on the class of stone which they handle and the final accepted pattern has usually been reached after a long series of experiments.

The men in charge of the crushers at the mines would be well advised to study the question seriously as, not only has the design of the jaws considerable bearing on the life which may be obtained from them, but it influences the performance of the machine as regards output and power consumption.

During a somewhat lengthy experience, the writer has on several occasions been surprised to discover the extent to which these two factors, power consumption and output, may be affected by the shape of the teeth.

The profile or cross-section of the teeth on the standard jaws as fitted in the machines by the makers will usually be proportioned on the following lines: The pitch is roughly equal to the size of product normally expected from the crusher; if a breaker is sold for 2½ inch cubes and under the pitch of the teeth would be 2½ inches. The included angle between the sides of each tooth would be from 90 to 110 degrees, the apex and root being practically sharp as shown in Fig. 1.

It frequently happens that with sharp teeth of the usual pattern, and when the teeth are new, the material hangs in the jaws more especially near the top when the crushing movement in the Blake machines is reduced to the minimum.

This trouble may be experienced with two distinct classes of stone, either with a tough and elastic material or with a very soft stone which carries a jacket or outer coating of decomposed substance most troublesome in damp weather. The sharp teeth do not penetrate far enough to rupture a very tough stone and the softer weathered material is held up by the wedge without actually being crushed.

To overcome this trouble it is necessary to blunt the apices of the teeth either by forming them to a larger radius, as in Fig. 2, or by making them with flat tops. It is true that wear would, in time, produce similar shaped teeth but the machine will give about half its normal output in the interval.

This trouble is always greatest when the teeth on the opposing jaws are sharp at the same time and many experienced crusher mechanics are in the habit of using a half-worn jaw opposite to a new one as, not only does this tend to reduce the trouble stated above, but, the average regularity of the product is better maintained thereby.

A comparison of the profile of the teeth in Figs. 1 and 2 will show that the latter design possesses greater potential life than the earlier pattern, the teeth have 30 to 40 per cent increase in cross-sectional area and this amount of extra metal has to be worn away before the jaws are discarded.

In addition to changing their shape the teeth may be arranged in a variety of different ways, some of which are beneficial while others, introduced to overcome some specific operating difficulty, may have a detrimental effect either on tonnage output or regularity of product.

Jaws with "staggered" teeth, as shown in Fig. 3, are used in some instances where cubical product

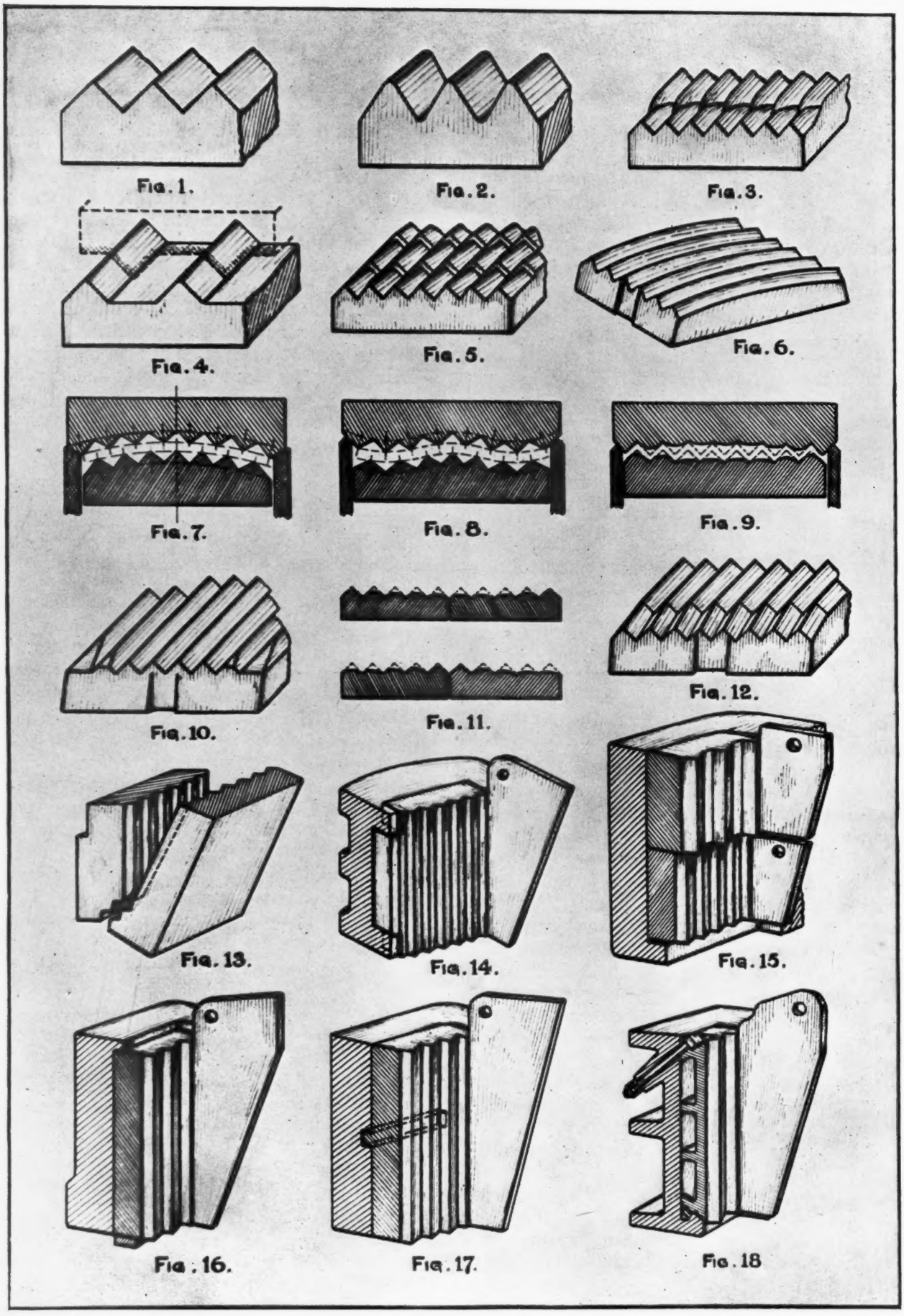


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 13.

Fig. 14.

Fig. 15.

Fig. 16.

Fig. 17.

Fig. 18

is essential. The continuity of the teeth is broken within two or three inches from the bottom of the jaws and a series of short teeth are inserted with the ridges midway between the pitch lines of the main teeth. These intersecting teeth are so placed that they intercept any long thin pieces sliding down the corrugations which might otherwise escape without being subjected to a final crushing "nip."

Jaws of this type undoubtedly improve the regularity and cubical shape of the finished sample to some extent but they impede the free discharge of the stone and seriously restrict the output from the machine. There are more economical methods which may be adopted for improving the quality of the product.

One of the leading English manufacturers of machines for breaking stone for macadam favors a special arrangement of wide-pitched teeth as shown in Fig. 4, for the upper half-jaws which act on the larger pieces of stone. If it were possible it would be mechanically correct to vary the shape and pitch of the teeth in proportion to the size of the stones on which these teeth have to act, using wide-pitched teeth at the top of the jaws and gradually tapering down to the required shape and pitch at the outlet.

For reasons of design such variable pitch jaws are not practicable but the pattern illustrated in Fig. 4 gives the wide pitch considered by some desirable to prevent over-crushing at the first reduction.

It will be evident that, assuming the pitch of teeth in the top half to be twice that in the bottom section so that the vertical lines of the teeth in the upper jaw coincide with every second tooth in the lower jaw, the level flat spaces between the wide-pitched teeth must project beyond or correspond with the apices of the teeth in the lower jaw; otherwise the intermediate teeth in the bottom section would form ledges which would hinder the free fall of the stone during crushing. It follows therefore that this system can only be correctly applied to stepped jaws as illustrated in Figs. 15 and 23, hereafter.

Another special form of tooth is shown in Fig. 5. In machines of the Acme type, where the eccentric shaft is journaled in the jawstock and the swinging or movable jaw has an upward and downward stroke in addition to its crushing and drawback swing, it will sometimes be found advantageous to serrate the teeth in the form of short steps as shown when crushing a slippery substance such as alum or materials of graphitic nature.

In the simplest form of jaw-plate the teeth are arranged on a flat back and follow plain parallel lines. The jaws may be divided into sections to render them more readily renewable, also to make it possible for the lower portions, where the wear is concentrated, to be reversed or renewed entirely without changing the other sections, but, in the majority of cases, the teeth are laid on a plain flat surface.

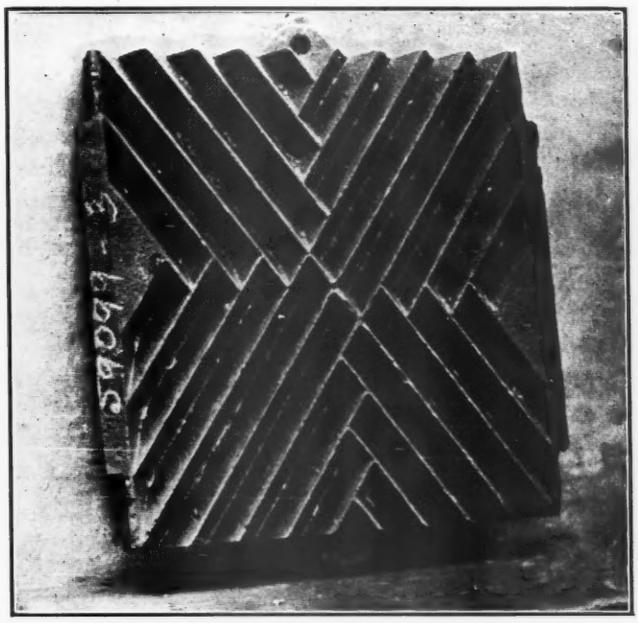


Fig. 3A. The "crazy-pattern" fixed jaw is an example of the lengths to which some engineers will go in their efforts to split the stone cross-ways as well as longitudinally. These jaws were used in machines working on a granite which broke naturally into flakey pieces and, according to information received, they improved the sample of stone.

Where the machines are small and the jaw-plates can reasonably be made each in one piece the writer favors the combination of a curved swing jaw with a straight fixed jaw. In this design the teeth are continuous from top to bottom of each jaw but the face of the swing jaw is made to curve outwards on its vertical cross-section as indicated by Fig. 6.

The effect of this curvature is to change the shape of the crushing cavity from a wedge-shaped chamber with straight sides to a similar opening with a curved hypotenuse.

In any jaw crusher which is fed by hand labor the blocks are fairly regular and the majority of the stones receive their first nip near the top of the jaws and then fall some distance down the cavity before receiving a second crushing. With the correct curvature the opening is restricted higher up the jaws and, below the center of curvature, the angle of nip is gradually reduced so that the smaller stones cover a greater selective area which gives freer and cleaner crushing.

This distribution of the fine crushing over a greater area has the further advantage of spreading the intensive wear over an increased surface, thereby prolonging the life of the jaw plates.

The curvature can be made on either jaw or, if preferred, it may be divided between both crushing faces, but care must be exercised to see that the angle-of-nip is not increased at the top of the jaws to such an extent as to cause trouble through the large stones being forced upwards.

This question of the angle-of-nip has an important bearing both in regard to wear and in rela-

tion to the output from the machine on certain grades of stone. In the whole range of crushers, from 10″ x 6″ size up to the 84″ x 66″ breaker, the included angle between the jaws will probably vary from 15 to 25 degrees; very rarely, even in the largest machines, does the angle exceed 25 degrees and 20 degrees is a fair average for the smaller units.

The larger and heavier pieces of rock are less liable to slip than smaller stones subjected to the same wedge-action and the construction of the jaw with vertical curvature is theoretically correct in so far as the angle-of-nip decreases as the size of the stone diminishes under the crushing forces.

The angle-of-nip should be reduced on certain materials. Slippery substances such as asbestos rock or rounded water-worn boulders are always liable to ride up and down between the jaws, not only causing considerable loss of output but greatly increasing the attrition on the toothed surfaces. A modification in the shape of the teeth as shown in Fig. 5 may be of service but the most effective remedy is to reduce the crushing angle.

In some very rare instances the jaws are made with the teeth arranged on a curved cross-section as shown in Fig. 7. It is probable that this design was originally put forward to give, in the jaw breaker, the same form of crushing opening as in the gyratory crusher, a well-known argument in favor of the latter machine being that the circular shape of the crusher head prevents the escape of thin flat pieces which pass with ease through the rectangular outlet of the jaw breaker.

The curvature is rarely sufficient to materially affect the product and, if the jaws are made reversible, the curvilinear feed-opening reduces the effective aperture for large stones.

When dealing with stones or ores which lie in laminated beds, and particularly when these materials have to be broken to the coarser finished sizes, the problem of the flat pieces becomes a really serious one. With a light feed these long thin slabs may fall right through the crusher opening without being reduced and they cause endless trouble by blocking chutes and jamming elevator buckets.

Various forms of "waved" jaws have been tried to remedy this trouble and Fig. 8 is a typical cross-section showing the undulating surfaces as usually adopted. In practice it is difficult to make the curves sufficiently pronounced to be really serviceable and jaws with wide-pitched teeth, arranged as in Fig. 4, are much more effective.

Although the teeth on the jaw-plate are commonly made of equal depth and contour across the full width of the plate they rarely wear away equally; in a good many instances less actual work is done near the side-walls of the crushing cavity than in the center of the jaws and the outside teeth remain perfectly unworn, as shown in Fig. 9.

These projecting teeth foul each other when the jaws are closed to maintain the aperture for a relatively fine product and the faces may have to be discarded for this reason before they are really worn out.

To overcome this difficulty and to obtain a better average product some users have the jaw faces made with chamfered teeth at the corners as illustrated in Fig. 10.

In very large breakers this uneven wear across the width of the jaw-plates is sometimes balanced by dividing the jaws into two sections and so arranging the teeth that each half-section can be reversed, after partial wear has taken place, bringing the practically unworn teeth into the center as shown in Fig. 11.

Generally speaking the wear is greatest at the lower edges of the jaws although it may not be concentrated at the actual extremities. In Acme type or single-toggle crushers it is customary to make the lower portion of the moving jaw at an angle to the main body of the teeth, see Fig. 12, so that a narrow face is formed which is roughly parallel to the plane of the fixed jaw to give a greater wearing surface in place of the point or line contact produced by two plane faces meeting at an angle.

Care should be taken that the depth of parallel opening is not made excessive; otherwise the material, instead of escaping freely, may be trapped by the return stroke of the jaw before it has time to fall clear, which causes packing and high power consumption. The writer has known cases where the action of the machine has been so far modified by badly designed jaws of this type that the greatest size of product escaping from the jaws was determined by the minimum opening between the teeth instead of the maximum as usually happens.

Fig. 13 illustrates a peculiar combination of jaw plates used by an English firm to reduce the proportion of flat or slabby pieces in the finished product. The lower portion of the cavity is abruptly deflected at a sharp angle to the vertical and the final crushing is done by a series of teeth set at right angles to the normal corrugations so that thin flat stones are subjected to a cross-breaking action before they can fall clear. The efficiency of most combinations of this character depends largely on their delaying action, which must, of necessity, cause some reduction in output.

Various makers adopt different means for securing the renewable faces to the frame and jawstock of the machine. In many instances the fast jaw is made to rest on lugs cast inside at the four corners of the front end of the frame, see Fig. 14, and the jaw is pressed against the bedding face by the wedging action of the side-checks, which have their vertical edges bearing on the sides of the jaw and their angular edges resting on projecting strips cast inside the frame of the breaker.

This system is good when the lugs have sufficient bearing area, but, owing to the clearance necessary for ease in fitting the jaw-plate, there is some

tendency for a slight movement to arise which will quickly destroy inadequate bedding surfaces.

When the fixed jaws are made in halves, with the upper half overhanging the lower as in the case of the "stepped" jaws shown in Fig. 15, the upper section may be secured from rising by means of lugs on the frame engaging with recesses in the jaw-plate, whilst the lower section rests on a ledge formed by a projecting lip on the end of the frame, a packing bar being inserted to eliminate any excessive clearance and reduce vertical movement.

"Stepped" jaws are rarely used by American manufacturers but with several English makers they are a feature of all standard crushers. Their use would, in any case, be more applicable to machines for producing cubical macadam rather than breakers for the mining industry.

The overhanging jaws are introduced with the object of obtaining a free space into which the stone may fall after its first crushing and before it is subjected to further reduction; the manufacturers also claim that the upper ends of the teeth on the lower reversible section are protected by the overhang on the upper jaw and are therefore in a better condtion when reversed.

Anyone who has studied the action of close-pitched teeth on the coarser stone will have noticed the way in which a homogeneous stone splits into thin slabs, which, being confined sideways by adjacent stones and compelled to slide down parallel tooth-spaces by the force of gravity, are broken again into laminar form. If it were possible the stones, after being split by the first crushing strokes, should be turned at right angles in order to present the newly formed flat faces to the breaking action of the lower teeth.

Whilst this ideal can hardly be attained in crushing machines of the usual type, the overhanging jaws would appear to be a step in the right direction especially when the crushed material is to be used for road-making or concrete and a regular cubical product is therefore particularly desirable.

Unfortunately it is rarely possible to obtain full advantage from the use of "stepped" jaws because the step cannot be made sufficiently pronounced without lengthening the jaws. A little consideration will make it clear that the free space below the upper jaws can only be obtained by raising the top sections or by a considerable restriction of the feed-opening.

When "stepped" fixed jaws are used it is advisable to make each of the cheek-plates in two sections to suit the variations in thickness of the jaws. This system has the additional advantage that the lower portion of the cheek-plate, on which the wear is greatest, can be renewed without discarding the upper and larger portion which may show little wear.

Another method of securing the fixed jaw is illustrated in Fig. 16. The jaw is prevented from rising by means of a projecting lip cast on the upper edge inside the frame, and is supported at its lower end on a flat mild steel cross-bar bolted underneath the body-casting. If the jaw section is made very slightly longer than the front end of the frame the bolts securing the cross-bar may be tightened to check vertical movement. The jaw-plate is confined horizontally by the wedge-action of the cheeks.

In some instances the lugs inside the end of the frame are replaced by cross recess in the center of the bedding surface for the jaw and a projecting lug on the back of the jaw locks the plate in position as indicated in Fig. 17. This system is not so reliable as those previously mentioned, jaw-plates are liable to fail by cracking or breaking into sections and the parts of a faulty jaw are not so likely to fall out of the machine if the plate is supported under the lower edge rather than at the center of its length.

When the frame of the crusher is made of cast steel and the fast jaw is manganese steel the latter may be shaped with cored pockets to receive clamping bolts which pass, at an angle, through the uppermost end of the jaw-plate and frame as shown in Fig. 18. With suitable lugs on the ledge at the lower end of the frame this makes a very rigid connection.

In the majority of cases the fixed jaw is held to its bed by the wedge-action of the cheek-plates, but this is not an invariable rule, as may be seen by examining the figure just mentioned. The design for the fixed jaw in Fig. 19 is another instance in which the crushing face is made secure without aid from the cheek-plates. Here the jaw casting has two centrally disposed dovetail projections whose lower edges engage with suitable recesses in the frame sides, leaving sufficient clearance for the insertion of two wedge bolts, one on either side, which grip the upper edges of the projections and lock the jaw against movement in any direction. This style of fitting is good so long as the jaw-plate remains intact.

Some of the French crusher builders make use of the construction shown in Fig. 20, in which projecting ledges are cast at both ends of the fast jaw and are made to overlap the front end of the frame. This system is open to the same objection as that shown in Fig. 19, with the added disadvantage that it is necessary, for manufacturing reasons, to allow some clearance in the gap between the ledges, with the result that the jaw-plate is never held quite rigidly in the vertical direction.

In some of the earlier crushers both fixed and swing jaws were secured in the manner indicated in Fig. 21. This method is very similar to that shown in Fig. 19, except that the wedge bolts are inserted through the frame-sides and above the jaws.

For machines of exceptional size the fixed jaw is

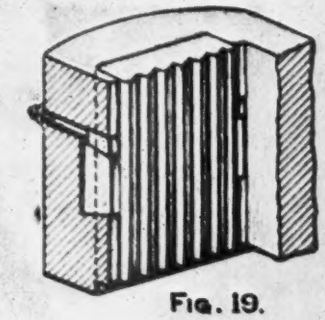


Fig. 19.

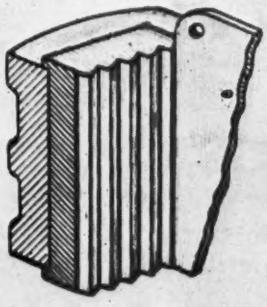


Fig. 20.

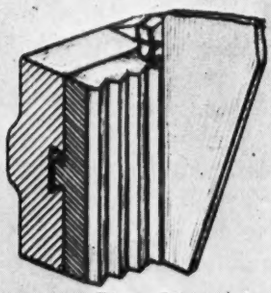


Fig. 21.

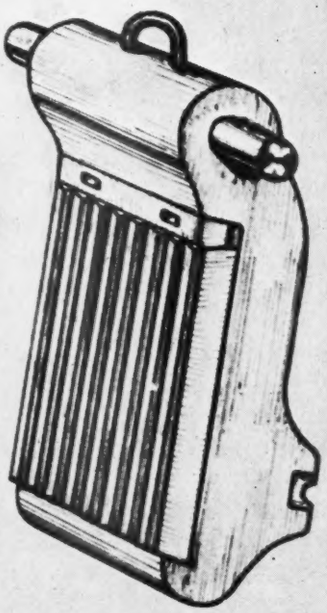


Fig. 22.

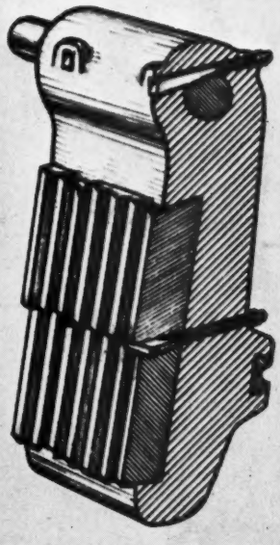


Fig. 23.

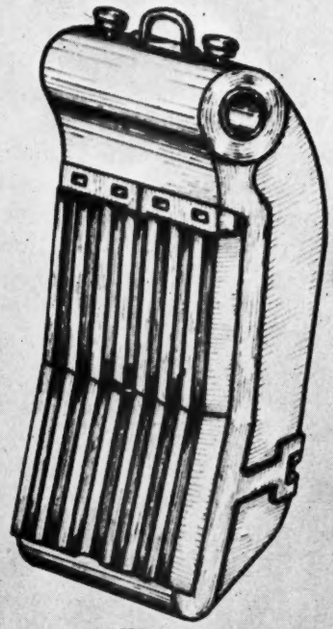


Fig. 24.

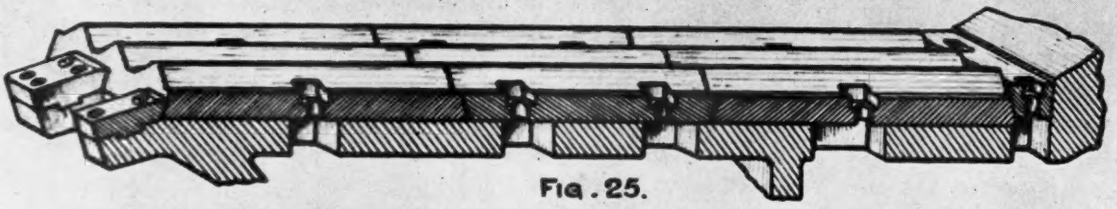


Fig. 25.

Fig. 26.

Fig. 27.

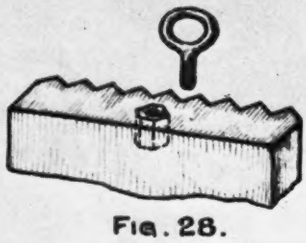


Fig. 28.

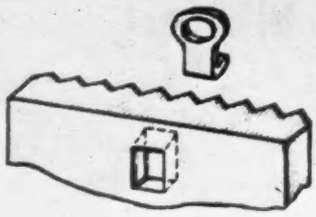


Fig. 29.

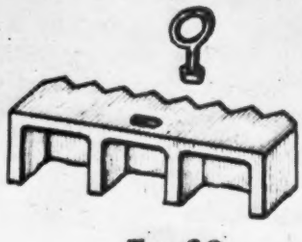


Fig. 30.

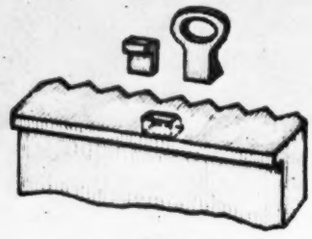


Fig. 31.

divided into four or six sections which are clamped to the front end-piece by means of bolts and, when six-piece jaws are used, the upper and lower plates are interchangeable and reversible, and the middle sections are made to overlap at the joints and assist in locking the others in position. End movement is prevented by wedge-blocks at the top of the jaw.

The construction usually adopted for securing one-piece swing or movable jaws is shown in Fig. 22. The upper and lower ends of the jaw-plate are beveled and a wedge-block or separate wedge bolts inserted between the projection on the jaw-holder and the top edge of the jaw, the bolts passing through the body of the jaw-stock.

When "stepped" jaws are fitted the two sections are frequently made with square ends each having two shallow wedge-shaped depressions which register with appropriate lugs on the bottom lip and upper ledge and form activities at the joint between upper and lower sections, permitting the introduction of two flat wedge-headed bolts which force the sections apart and clamp the combination to the jawstock.

This system has one great drawback: the nuts on the tightening bolts are very difficult of access, but the sections are well-secured against side and end movement and against any tendency to lift from their bed.

Another contrivance for movable jaw-plates in two sections is shown in Fig. 24. In this case the seating is not a plane surface but is made slightly concave, the two jaws meeting at the center of the depression. Each section has a flat back and is made with ends slightly beveled; the castings are symmetrical and are both interchangeable and reversible.

The bottom lip on the jawstock is shaped to correspond with the bevel of the middle joint and when the two sections are forced downwards by the locking wedge at the upper end of the jawstock they are perfectly secure against movement in any direction. The wedge-bolts are also brought into a more accessible position than in Fig. 23.

It is to be regretted that with its outstanding mechanical advantages this system is open to serious objection from the operating view-point, but the fact remains that, even with a departure of not more than six degrees from the true plane, there is a decided tendency for the "cupping" action to cause packing, which increases the proportion of dust in the finished product, and incidentally adds to the power consumption.

Fig. 25 is a longitudinal section through the jaw-plates attached to the jawstock of a large size breaker. The method of attachment is the same for both fixed and swing jaws except that the latter have projections on their undersurfaces fitting into machined grooves in the bed of the jawstock to prevent the sections from spreading sideways and crowding against the cheek-plates. The upper and lower sections are reversible and interchangeable and all the plates are bolted direct to the containing casting.

The nuts on the bolts securing the plates to the jawstock are almost inaccessible in many cases and the entire swing-jaw and holder must be lifted clear before the plates can be changed.

With jaw-plates of any size it is advisable to arrange for the easy insertion of some form of lifting hook or eyebolt to insure safety in handling. The tee-shaped slot shown in Fig. 26, in conjunction with a tee-headed ring-bolt, forms a handy and reliable means for removing the jaw-plate expeditiously. Fig. 27 illustrates a combination of semi-circular groove and lifting link much favored by continental manufacturers, which is more applicable to thick chilled-iron jaws than to the thinner sections now common when alloy steels are used.

In Fig. 28 a hexagon nut or a plug of special shape is shown cast in each end of the jaw so that a screwed eye-bolt may be inserted for lifting purposes. Whilst this is a very positive and safe lifting device the plugs tend to create slight cracks in the casting and may ultimately cause a breakage which might otherwise have been avoided.

Fig. 29 illustrates one of the older forms of lifting hook which fits in a recess in the back of the jaw made with an undercut or dovetailed end to prevent the plate from slipping off the hook when the weight is taken on the lifting chain.

When the backs of the jaws are chambered to reduce their weight the lifting bolt very frequently takes the shape shown in Fig. 30. Slots are cored through the end-walls into the cavities formed in the back and the eye-bolt is inserted and given a half turn to bring the tee head into the safe position.

Fig. 31 shows a wedge-bolt with locking key such as is ued for handling large blocks of masonry; this system is sometimes adopted for dealing with heavy jaws. It is not always possible to get clean dovetailed recesses in the castings and improper fitting is dangerous, so that the other methods can be relied on with greater certainty.

For a considerable number of years cast iron was practically the only material used for the manufacture of jaw-plates for crushers. The teeth were chilled to increase their wearing properties and the body made of sufficient thickness to give a tough backing to the brittle wearing face.

With the introduction of the higher grades of alloy steel and more especially from the date of the discovery of manganese steel by Sir Robert Hadfield in the year 1883, steel has very largely displaced the chilled iron.

Manganese steel is pre-eminently suited for this particular duty; this alloy has the property of artificially increasing the hardness of the wearing face in proportion to the intensity of the pressure, in

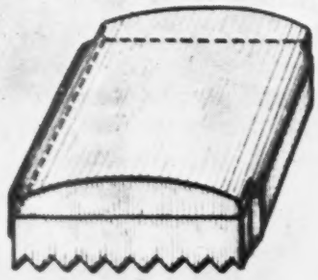


Fig. 32.

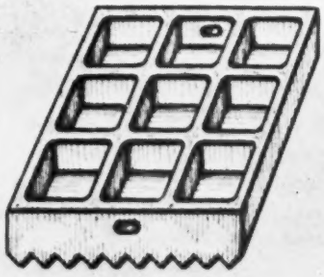


Fig. 33.

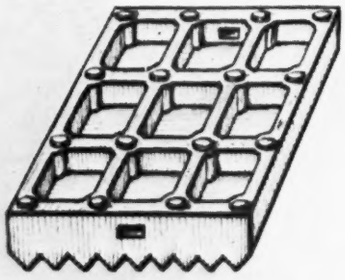


Fig. 34.

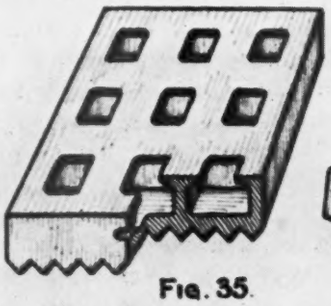


Fig. 35.

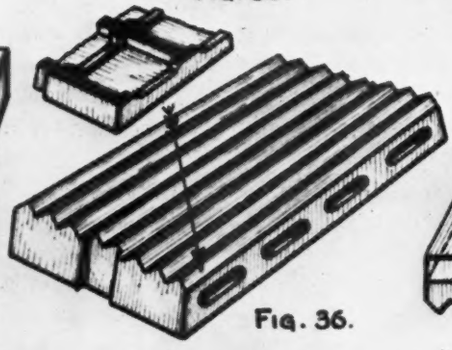


Fig. 36.

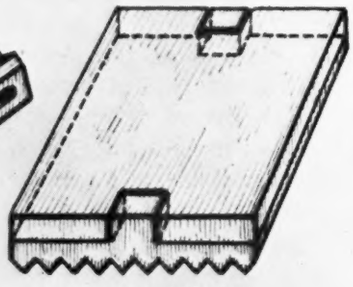


Fig. 37.

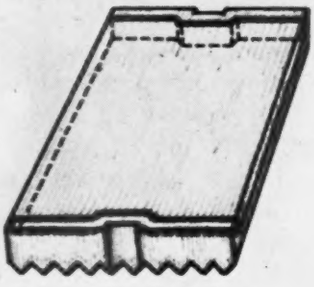


Fig. 38.

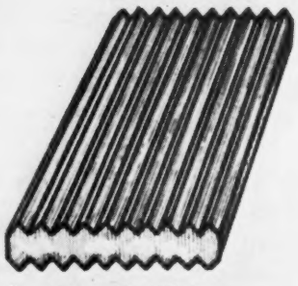


Fig. 39.

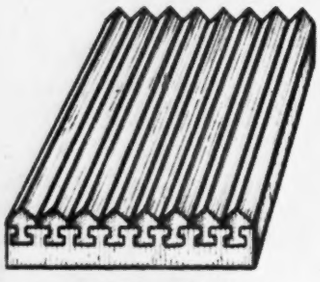


Fig. 40.

Fig. 41.

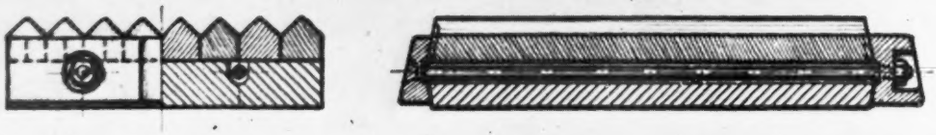


Fig. 42.

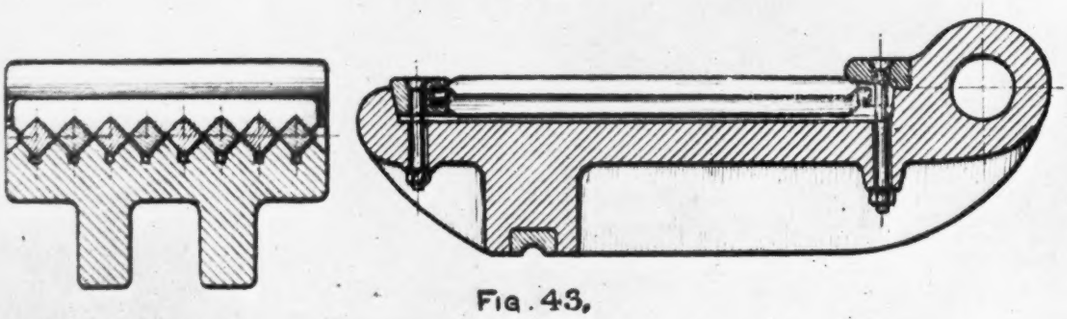


Fig. 43.

other words the tougher the stone which is being crushed the harder becomes the crushing surface which is opposed to it, and this artificially hardened face is maintained notwithstanding the loss due to abrasion.

Chrome steel is now only used occasionally for special jaws and it is possibly close to the mark to say that seventy-five per cent of the jaws in service today are made of manganese steel.

In addition to great advantages this latter material has some peculiar properties which require to be better understood by those who use it. Although it is practically unmachineable by means of the ordinary cutting tools and can only be dressed by emery-wheels it is not essentially a hard material; indeed, in its treated condition, it is very ductile and tends to spread or burr-over under any hammering or squeezing action.

Because of this property it is necessary to allow ample clearance between the sides of the fixed jaw and the walls of the crusher frame; otherwise the plates may spread and wedge into the opening, making it extremely difficult to remove them when worn out.

When a manganese steel jaw is made of a number of separate sections the teeth subjected to the greatest wear at the lower end of the jaw may become so badly burred-over that it is not possible to reverse the section without first removing, by grinding, the lip so formed.

Castings made from manganese steel are subjected to a heating and quenching process before leaving the maker's works and should not be reheated, locally or otherwise, before being put into service. As previously stated the wearing surface should harden under work, but this hardening can only take place when the material being crushed is itself of a hard and resistant character. It follows therefore that, when dealing with the softer rocks, chilled iron may give an equal, if not a greater, life at an appreciable reduction in cost. Rapid wear under apparently easy conditions should not always be taken as reflecting on the quality of manganese steel supplied.

Where it is desirable to maintain a thick jaw which can be worn beyond the limits of the usual depth of chill in cast iron, such, for instance, as the flat jaws without teeth used for crushing corundum or any of the artificial abrasives, chrome steel or a special high-carbon steel will be found most suitable.

It frequently happens that a jaw-plate has to be scrapped when only a small proportion of the metal surface has been worn away. Sometimes the teeth may still be quite good in the center of the plate and in nearly all cases the body of the jaw remains intact. These constant additions to the scrap pile are a source of annoyance to any right-minded superintendent. They cannot be avoided entirely but the dead-weight loss can often be reduced.

In a large number of crushers which are still in service the jaws have been designed for manufacture in chilled iron and are, of necessity, of considerable thickness under the teeth. Even in chilled iron it is possible, in some instances, to effect economies by making a crushing face and a separate backing plate as shown in Fig. 32, which illustrates a composite fixed jaw with a curved back.

When steel is used in place of cast iron it is neither necessary nor advisable to make the jaws solid, especially as this would mean the throwing away of a good deal of expensive material when the plates are worn. The design shown in Fig. 33 was therefore introduced to economize material and the thickness for the side-walls, cross ribs and under the teeth was reduced to one or one and a quarter inches.

Under the constant pressure the narrow ribs eat their way, in course of time, into the bedding surface of the frame or jawstock, and, as castings will always vary slightly, new jaws may not register in the recesses made by the earlier castings, with the result that improper bedding is caused with consequent loss in crushing efficiency.

Various modifications have been introduced to overcome this trouble. Some engineers fill the recesses with concrete, others pack the cavities with scrap iron and cover the back with molten spelter to a thickness of about one-quarter of an inch beyond the ribs. When the jaws are discarded the scrap and zinc are melted out and used over again. Another method consists in driving hard-wood blocks into the pockets, allowing them to project slightly and afterwards planing them to a level bed.

A further type of backing is illustrated in Fig. 34, where round pads of spelter are run into dovetailed recesses at the intersections of the ribs. This system of construction can hardly be said to increase the bedding surface as it merely introduces a limited area of yielding backing which quickly squeezes down under work. It is useful, however, for overcoming inaccuracies of level in the back of the jaw-plate or the bedding face in the machine.

Some makers dispense with any soft backing medium but introduce a mild steel plate between the jaw and the frame or jawstock so that this false back can be replaced when the surface becomes destroyed by the cutting action of the ribs.

Crushing efficiency depends on solidity and the design shown in Fig. 35, in which the bases of the ribs are splayed outwards to give greater bearing area and the bedding surface machined or ground to a true face, is far superior to any of the foregoing types.

The Broadbent jaw, illustrated by Fig. 36, was designed to obtain the advantage of a solid back

on a cored-out jaw of light weight suitable for manufacture in manganese steel to replace solid jaws made of chilled iron. The through cores were arranged to run from side to side of the face, leaving continuous supporting ribs between the back-plate and the metal under the teeth, the supports crossing the line of the teeth.

As usually made these Broadbent jaws have a number of circular dovetailed recesses for securing a thin layer of spelter to the rough face of the casting. They can, however, be made without this false backing by grinding the bedding surface to a plane face.

One or two plants use composite jaws as shown in Figs. 37 and 38. Here the actual crushing face is made as thin as possible commensurate with strength and the remainder of the depth is made up by a loose backing-piece of either cast iron or cast steel, preferably the latter. To secure the two portions in position the jaw casting is made to flange over the back-plate at either end, sometimes for the whole width, as shown in Fig. 38, at others merely in the form of central projections, as illustrated in Fig 37. These jaws have the advantage of reducing the amount of material which is thrown away to a minimum.

Fig. 39 shows a jaw with teeth on both front and back faces. This type can only be used either with a grooved bedding face in the frame or jawstock or with an intermediate packing plate including suitable recesses. No doubt spelter is used to make good any deficiencies in the bedding surfaces but, when the jaws are reversed, the teeth, or what remains of them, will most probably have become distorted by the work of crushing and the bed will require to be modified to correspond.

The design shown in Fig. 40 was made to give a composite jaw with teeth of extra hard-wearing steel set in a softer back. The teeth were cut from rolled bars made in chrome steel, holes were drilled at intervals through the vertical webs, and the sections were laid in the mould and the soft steel back was then run in to bind the whole together. With the great variety in the shape and size of the teeth the cost of manufacture must have been high, for this construction quickly fell into disuse.

Renewable teeth have from time to time attracted the attention of patentees and manufacturers and Figs. 41, 42, and 43 may be taken as representing types which have come within the experience of the writer of this article.

The first was introduced by an English firm several years ago and the last is a Swiss design which illustrates the renewable feature in its most highly developed form. In all cases the toothbars are rolled in specially hard steel. In Fig. 41 they are secured in a steel container and locked by a packing wedge; to give greater security the two outermost bars are grooved to fit the sidewalls of the holder.

In Fig. 43 the bars are square with rounded tapering ends having centering projections. They are wedged down into vee-shaped grooves by means of clamping plates at either end, this form of construction ensuring that each individual bar is prevented from side-displacement. It is claimed that the bars may be turned over when worn, but the irregularity of the wear must cause unequal bedding and it is doubtful whether such an advantage can be obtained in practice.

The defects of these jaws are obvious: there are too many loose parts, or parts which may become loose or distorted under the severe wear entailed in crushing a hard or tough material. The simpler the construction of a jaw-plate the more likely it is to give satisfaction.

Enough has been written to show that the shape and arrangement of the jaw plates is a matter worthy of serious attention and that advances have been made in improving the designs both from the point of view of economy in the use of material and as regards the most suitable conformation of the teeth to meet given conditions.

Progress should be continuous in all human affairs, and the detailing of ideas from many sources may stimulate the inventive faculty in the men who use the machines or, at least, lead to a better understanding of the possibilities in this direction.

Foreign Trade Analyzed

The United States spends more money in Asia for merchandise than in any other section of the globe. Europe leads all other parts of the world in the purchase of U. S. goods.

These are the outstanding points of a study of American foreign trade for the first four months of 1927 just completed by the U. S. Commerce Department. In this period, the United States exported to foreign countries merchandise valued at $1,616,000,000 and bought from other countries goods worth $1,422,000,000.

Europe took 47 per cent of all goods exported from the United States, purchasing a total of $760,000,000. Fom Europe, this country bought goods worth $412,000,000, which was 29 per cent of the value of all goods imported by the United States from all countries.

Asia shipped to the United States goods worth $435,000,000, representing 30 per cent of our total foreign purchases. But Asia bought from the United States goods worth $209,000,000 or 13 per cent of all our sales abroad. North American countries bought $387,000,000 worth of our goods and sold to the United States merchandise valued at $329,000,000. South America bought $154,000,000 worth of U. S. goods and sold us $183,000,000.

MILLION DOLLAR FREIGHTER "S. T. CRAPO" LAUNCHED BY HURON PORTLAND

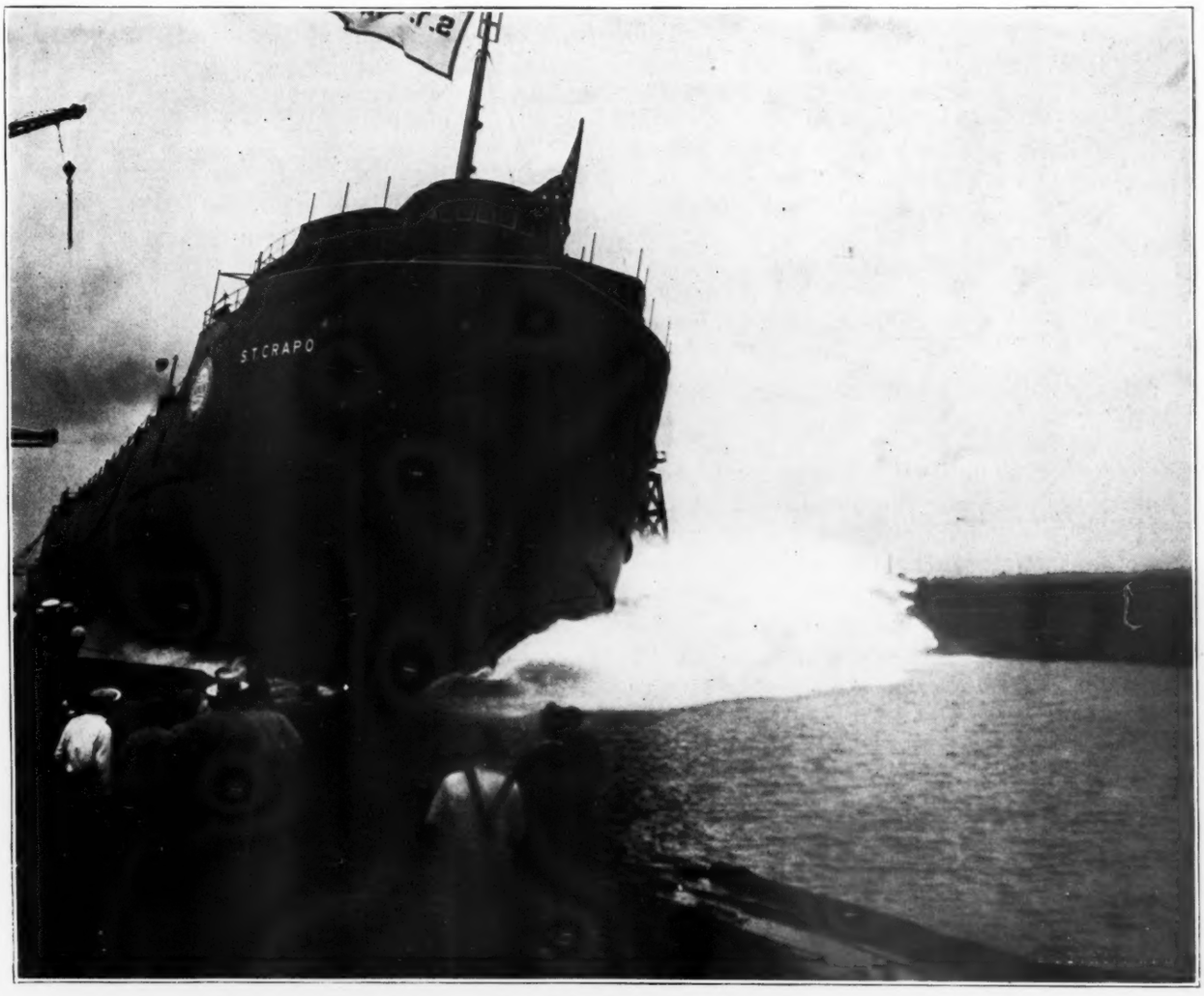
THE Huron Portland Cement Company, Detroit, Michigan, added another ship to its fleet of bulk cement carriers on July 7, when the "S. T. Crapo," the largest, most modern self-unloading bulk cement carrier on the Great Lakes, was launched at the Great Lakes Shipyard at Ecorse on the Detroit River. This new steel bulk carrier has a capacity of 7,500 tons, equivalent to 160,000 sacks of cement. The Huron Company is the pioneer in transportation of bulk cement on the Great Lakes, and the unique mechanical equipment has been built after designs by the company's engineers.

The "Crapo" joins the "John W. Boardman" and "Samuel Mitchell" and will be employed exclusively in transporting "HIGH GRADE" Huron Portland cement for the company's plants at Alpena, Detroit and Wyandotte, Michigan, Duluth, Minnesota, Milwaukee, Wisconsin, Cleveland, Ohio, and Buffalo, New York. The new steamer is 400 feet long, has a depth of hold of 29 feet and is 60 feet wide. Three 2,000 horsepower Scotch marine boilers and a triple expansion engine will give a running speed of 13 miles per hour. The electrical equipment includes three turbo generators. The cost complete was in excess of $1,000,000 and a crew of 35 men is required in operating.

The unique mechanical equipment enables the new ship to unload a capacity cargo equivalent to 160,000 sacks of Portland cement in 10 hours without aid of any unloading machinery on the docks. A capacity load can be taken on in four hours.

The Huron Portland Cement Company chartered exclusively the passenger steamer "Wauketa" to privately conduct the launching party of 600 invited guests to the shipyard. Promptly after the arrival of the party at the shipyard on the Detroit River the new steamer was allowed to slide into the water.

One of the interesting and unusual features of the launching of the "Crapo" was the fact that smoke issued from her stack and a blast from her own whistle answered the salutes of steamers in the vicinity as the ship slid down the ways into the water.



The New Million Dollar Freighter "S. T. Crapo"

Miss Anita Boardman, daughter of John W. Boardman, vice-president of the Huron Portland Cement Company, christened the "Crapo," named after Stanford T. Crapo, secretary-treasurer of the company. The christening party included John B. Ford, president of the Huron Portland Cement Company, John B. Ford, Jr., Fred Ford, John W. Boardman, W. W. Crapo, son of S. T. Crapo, and Paul H. Townsend, connected with the Huron Company, also W. B. Mayo and E. G. Liebold of the Ford Motor Company. A number of guests were present from various sections of Michigan and adjoining states, among whom were B. F. Affleck, president of the Universal Portland Cement Company, and George S. Bartlett of the Universal Company, Chicago, Illinois, and Wm. M. Kinney, general manager of the Portland Cement Association.

Following the launching, luncheon was served to the guests on board the "Wauketa" and the party was taken to the company's private dock at Wyandotte for an inspection of the new Wyandotte cement manufacturing plant before the return trip to the docks at Detroit.

The launching party aboard the "Wauketa" included John W. Smith, Mayor of Detroit; John S. Haggerty, Secretary of State; William H. McKeighan, Mayor of Flint; Mayor L. G. Defoe of Alpena; John W. Reid, Commissioner of Public Works, Detroit; Perry A. Fellows, Detroit City Engineer; George H. Fenkell, Chief Engineer and General Manager of the Detroit Water Department; Edward N. Hines, Chairman of the Wayne County Road Commission, and Fred L. Woodworth, Collector of Internal Revenue, Detroit; also Thomas E. Curie, Julius Porath, John A. Mercier, W. A. Detwiler, and other prominent contractors and builders.

Minnesota Now Has Longest Road Built of Concrete

The longest continuous stretch of concrete roadway in the world has just been completed between White Bear and Duluth, Minnesota. This pavement passes through 29 towns and villages over its 137 mile length.

Paving construction on this thoroughfare, State Trunk Highway No. 1, was begun in 1923. Highway authorities point out that the completed highway will save a great deal of money through low maintenance costs. Maintenance costs for gravel surfacing on this highway have been as much as $3,000 a mile, state highway records show.

This Minnesota pavement is two miles longer than the concrete pavement extending from Olympia to Vancouver, Washington. The third longest length of concrete rural pavement reaches from Kansas City to a point west of Columbia, Missouri, a distance of 125 miles.

Reading Easier and More Pleasant in Pit and Quarry

L. A. Stack of the Lehigh Lime Company writes concerning Pit and Quarry:

"This publication holds a live interest for the writer, particularly, as regards the activities of the Lime and Cement industry. Of all the publications received, Pit and Quarry by virtue of its large clear type makes reading so much easier and much more pleasant.

"The technical articles and the editorials covering current events are enjoyed because this company caters especially to the chemical industries, where lime is used in a great many industrial processes. We want to take this opportunity of congratulating you on the large and steady growth of Pit and Quarry."

Magnesia Cements

Magnesia cements are rendered impervious to moisture by the addition of a waterproof colloid like lead soap and of a dispersing agent like casein to maintain the waterproof substance in its colloidal condition until the composition has set. For example, 2-4 parts of an ammonium soap and casein and 4-6 parts of lead acetate are added to 30-35 parts of magnesia, 15-20 parts of sawdust and 2-6 parts of fillers such as plaster, lime and silica; 30-40 parts of magnesium chloride are then added. —Soc. Le Xylium (British Patent 269,518).

Synthetic Minerals, Cement and Blast Furnace Slag

Alite can be produced in only one crystal phase from the shaft kiln clinker. By the use of blast furnace slag rich in alumina as raw material, the lime content is correspondingly lowered. Alite, therefore, is produced from a mixture of two minerals, a calcium alumina silicate and a calcium silicate. By unusual operation of blast furnace a slag can be produced containing 20% Al_2O_3. and 49% CaO, which made a good cement when finely ground. Ray cement slip under the same conditions gave no cement, in fact a mixture of bauxite and precipitated silica produced a blast furnace slag rich in alumina. One of these compounds, $Al_2O_3 \cdot SiO_2 \cdot 4CaO$, the corresponding crystallite, serves as a component for the formation of alite.—W. Schoerk (Tonind. Ztg. 51, 462-463).

Heat Resisting Products from Zircon-Earths

The zircon earth is calcined in an oven and the mass immediately upon discharge treated with a powerful stream of cold water containing 1/10 of one per cent sulphuric acid.—Societé d'Etude des Agglonieres (German Patent 442,916).

PIT AND QUARRY FOREIGN DIGEST

Heat Generated by Rapid Hardening Portland Cement

Experiments were made comparing the heat generated by "Ferrocrete," rapid hardening Portland cement, and ordinary Portland cement. A mortar was made in each case consisting of three parts Leighton Buzzard sand to one of cement together with water to the amount of 12% of the weight of the mixture. The mortars were gauged, and placed in thermos bottles with further insulating precautions and arrangements for gauging the temperature. The rise in temperature of the mortar as a function of the time was determined. After 12 hours, it was found that more than three times as much heat was evolved by the rapid-hardening Portland cement as by the ordinary variety, and after 24 hours, the rapid hardening mortar was still 100% above the other. At the end of four days the rapid hardening cement generated 30% more heat than the other.—Anon. (Conc. & Const. Eng. Vol. 22, pp. 332-333).

Retarding the Hardening of Cement By Addition of Small Amounts of Lead Oxide

Portland cement was intimately mixed with various amounts of lead oxide and 28% of water, and the penetration of the Vicat needle measured after various intervals. Figure 1 shows the penetration of the needle plotted against the time in hours, for concentration of PbO, varying from 0 to 1.0%. Pure cement begins to harden in 4 hours and 10 minutes, and requires 6 hours and 20 minutes to set. 1/1000% PbO increases the setting time to 9½ hrs., and larger additions have increased effects. Up

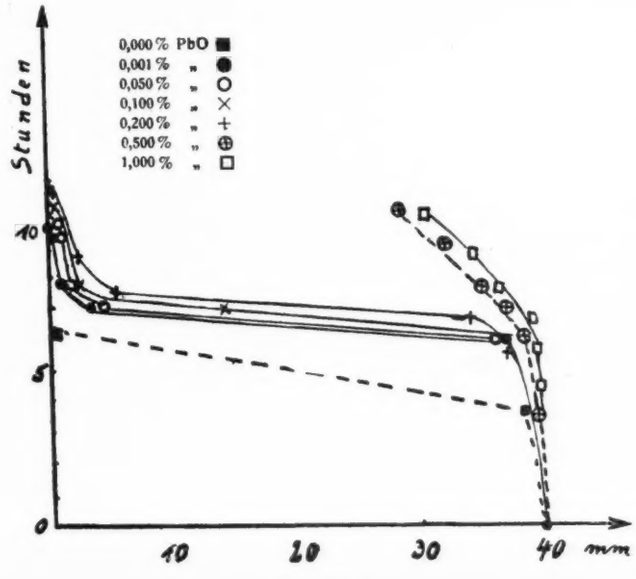


Figure 1

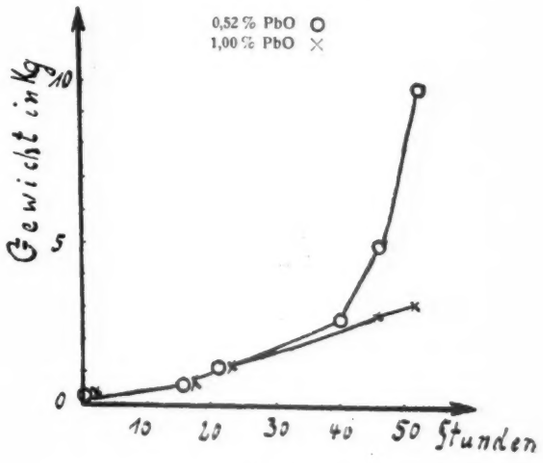


Abb. 2

Figure 2

to 0.2% content the cement starts hardening in about 6 hours. The greater the lead oxide content, the slower the hardening, and with these low percentages, the hardening interval is very short, once it begins. With as much as 0.5 and 1.0% PbO, the hardening is retarded to such an extent that it takes place very slowly even after it starts, and requires more than 50 hours instead of 10. Figure 2 shows the weight on the Vicat needle which is necessary to secure complete penetration of the needle in the cement at different intervals, with concentrations of PbO of 0.5 and 1%. As little as 1/1000% PbO causes a very noticeable retardation of the cement hardening, greater PbO additions having only a slightly increasing effect. B. Garre (Zement. June 19, 1927). (Fig. 1 & 2. "Stunden" = hours. Fig. 2 "Gewicht in Kg" = weight in kilograms).

"Gas" Concrete

Porous concrete suitable for building construction is made from a mixture of 40% cement and 60% of a 1:1 mixture of lime with shale ash, to which is added a small quantity of powdered aluminium. The hydrogen generated in contact with water makes the mass porous. The heat conductivity is such that a 6-inch wall prevents heat transmission as efficiently as an 18-inch wall made of ordinary brick.—F. Huth (Allgem. Brauer Hopfenztg. & Chimie et Industrie 17, 432).

Aluminous Cement in Hot Weather

In the construction of a reinforced concrete bridge in France, where aluminous cement was used throughout, it was found that one small section did not set properly and the cause was traced to the hot weather (97 degrees F.). Aluminous cement concrete should not be exposed to the sun in warm climates when setting. Editorial (Conc. & Const. Eng. Vol. 22, pp. 295-296).

Rapid Hardening Concrete

Concrete made with the rapid-hardening Portland cements has so many advantages over ordinary Portland, and the increase in cost is so small, that its general adoption is only a question of time. These cements are simply a superior grade of Portland. Their rapid-hardening qualities are derived from a general improvement in manufacture in all stages. In spite of a greater lime content, they conform to standard specifications of Portland cement. The concretes made from the rapid-hardening variety attain in four days the same strength that the ordinary cement concretes reach in 28. The heat generated in setting makes the improved cements much easier to use in cold weather. In mixing the rapid hardening cements the water content should be kept at a minimum. They are less pervious to water.

Aluminous cements are a second form of rapid hardening cements which, for some work, are unique in suitability. In 24 hours, a 3:1 mix with sand acquires a strength of 7430 lbs. per sq. in. Reinforced concrete piles made of aluminous cement may be driven at the end of 48 hours. The concrete must be kept flooded with water during the early setting period. Aluminous and Portland cements should never be mixed and contaminations of the two, even in small quantities, must be rigorously avoided.—W. L. Scott. (Conc. & Const. Eng. June, 1927, pp. 367-371).

Bituminous Concretes

A dry mixture of a mineral aggregate and cement, lime, plaster, etc., is mixed with a bituminous soap prepared by adding a saponifiable oil, with or without resin, to a bituminous substance, and treating the mixture with dilute alkali. E. g., 100 parts of bitumen is mixed with 10-20 parts vegetable oil, and the mixture saponified with weak alkali lye, and 4-20 parts of the resulting emulsion are added to a mixture of 20-75 parts of broken stone and 1-7 parts of Portland cement. The concrete may be used as a mortar between larger pieces of broken stone, or between paving blocks of stone, wood or rubber.—L. S. van Westrum (British Patent 269,-975).

Acid-Proof Cement

An acid-proof hydraulic cement resembling Portland or Roman cement contains barium instead of calcium compounds. As raw material barium sulphate or carbonate may be used; this is mixed with sand, clay or the like, crushed and burned at or below the sintering temperature, or the charge may be completely fused. Reducing agents such as coke may be added. When using barium sulphate the resulting sulphur dioxide may be used for the production of sulphuric acid. The chemical-resisting properties of the cement are increased by treating it with SO^3 ions; this may be effected by adding sulphates before or during the final grinding, or by treating articles made of the cement with sulphuric acid or magnesium or ammonium sulphate solution. The setting time may be controlled by addition of gypsum. The cement should preferably contain a proportion of aluminium silicate or of iron oxide.—Port. Cement Werk Bal. Ges. (British Patent 269-549).

Magnesium Chloride in Mortars

In Denmark the discovery was made that the addition of $MgCl_2$ to sand-lime mortars lowers the freezing point of the mixture to a very marked degree without, apparently, having a deleterious effect upon the strength of the hard mortar. An excess must be avoided because the magnesium salt is very hygroscopic and may keep the mortar damp even after it has set. As the mortar is always used in conjunction with damp stone, it is fair to assume that about half of the magnesium salt will be absorbed by the stone. No more than 5.8% of the weight of the lime should be taken of $MgCl_2$ and this figure might perhaps be reduced to 4.5% as the amount remaining in the mortar. A maximum percentage of 9% of the lime should, therefore, never be used. A composition of a normal mortar is: 92 parts sand, 8 parts slaked lime, 25 parts water and 0.72 parts magnesium chloride. This salt should be used with caution until further investigation of its properties is made. It might also be applied to concrete, but not to reinforced concrete due to the corrosive action of the salt on iron.—"Dr. S." (Beton u. Eisen. Vol. 26, pp. 188-9, 1927).

Stone Crushers

In a stone breaker, breaking or crushing and granulating teeth are formed in each jaw, so that the crushing and granulating processes are carried out simultaneously. The teeth of one jaw are so formed as to fit between the teeth of the other jaw. Granulating teeth are provided at both ends of each jaw so that the jaws can be reversed when they become worn.—R. Waddell & Acme Steel & Foundry Co. (British Patent 269,833).

Crushing Machines

Vibration is eliminated in a group of two or more crushers or similar machines, each of which is operated by means of an unbalanced revolving weight, by causing the actuating weights of the crushers to travel so that an unbalanced force tending to vibrate one crusher is always equal and opposite to a force tending to vibrate another crusher of the group. With gyratory crushers, the movable crusher heads are caused to gyrate in predetermind phase relations to each other.—Allis-Chalmers (British Patent 269,866).

INTIMATE NEWS OF MEN AND PLANTS

Big Glass Sand Merger

The merging of the big glass sand companies around Hancock, Maryland, and Berkeley Springs, West Virginia, and the formation of the Pennsylvania Glass Sand Company under the laws of Pennsylvania, with a capitalization of $15,000,000, is reported from Baltimore, Maryland, after a meeting of the directors of the new corporation.

The new organization is to acquire the entire properties and assets of the Pennsylvania Glass Sand Company and the physical properties of the Maryland Glass Sand Company, Inc., Berkeley Glass Sand Company, E. F. Millard Sand Works, West Virginia and Pittsburgh Sand Company and Pittsburgh White Sand Company of West Virginia.

The Maryland Glass Sand Company is controlled by the Funkhouser interests, it was stated, Raymond J. Funkhouser being the president. It is capitalized at $250,000. The Pennsylvania Glass Sand Company has its general offices at Hancock.

A. J. Fink, of Baltimore, was made chairman of the board of the new corporation while Addison E. Millikin and Henry F. Bridges will be members of the board. For the purpose of providing funds to acquire the various properties in Maryland and West Virginia an offering of securities in the new corporation amounting to $8,000,000 will be made. The offering will consist of $5,000,000 first (closed) mortgage 6 per cent sinking fund bonds and 30,000 shares of cumulative convertible preferred stock without par value. Capitalization of the company will also include 30,000 shares of common stock.

The merger takes in all the properties in the territory except the Hazel Atlas Co., at Great Cacapon, and the National Salica Works, the pulverizing plant located at Berkeley Springs.

Hudson Buys Gravel Plant

According to a report from Kittanning, Pennsylvania, the plant of the Hudson Sand and Gravel Company, located on the west side of Water street, north of Hazel street, has been taken over and will be operated by Captain James M. Hudson and his son Henry. Under the agreement reached the equipment is purchased outright and a lease is taken for a period of five years on an acre of land including that on which the plant is located. The Hudson Sand and Gravel Company is composed of a number of well known local people.

New Lime Plant to Be Built at Swatera, Pennsylvania

A new lime plant will be built at Swatera, Pennsylvania, by Walter T. Bradley. Swatera is on the Reading Railroad ten miles from Harrisburg. The new plant will produce 100 tons of raw lime per day from a high calcium stone. There will be four kilns of the York gas producer type. A wood automatic gas producer will be used. The material will be automatically handled from draw to cars. The McGann Manufacturing Company are engineers and builders for the new plant.

Death of William L. Hodgkins

William Lewis Hodgkins, president of the Brownell Improvement Company, of Chicago, contractors and operators at Thornton, Cook County, of one of the largest crushed stone quarries in the world, met with an untimely death on the night of Wednesday, July 6, when his speed yacht Playboy suddenly became enveloped in flames in Georgian Bay, near Little Current, Ontario. Shortly before the accident Mr. Hodgkins had started from the village of Little Current for his summer camp at McGregor Bay. He had taken two young Chicago girls aboard at Cutler for a visit to his camp, where his wife, Mae Press Hodgkins, and his son, William Press Hodgkins, awaited him. A dozen other members of the McGregor Bay summer colony had embarked earlier on a chartered boat for the camp and were some distance ahead of the Playboy at the time of the accident. With Mr. Hodgkins at the steering wheel, the engine of the yacht backfired and in a moment the hull was in flames. A leak in the gas tank is believed to be the cause of the almost instantaneous spread of the fire.

Mr. Hodgkins, the survivors declare, shouted for all to leap overboard, himself remaining on the craft until the last moment to toss overboard to others the seat cushions and other objects to aid in the long swim ashore. When he finally leaped in he was too fatigued, although a good swimmer, to withstand the frigid temperature of the water. Thomas Fleshman, a deckhand, and James Rush, a mechanician, also perished. The two young girls, Misses Winifred Smith and Miss Emily Otis, escaped by swimming to Mary Island together with two members of the crew.

Mr. Hodgkins was born in Chicago 52 years ago and became connected with the Brownell concern 30 years ago after his graduation from Purdue University. He succeeded his father as president of the company in 1922.

William L. Hodgkins

Wisconsin Not to Build State Cement Plant

According to a report from Madison, a bill introduced in the upper house of the Wisconsin legislature by Senator Alex Ruffing, of Milwaukee, providing for a joint legislative committee to investigate the feasibility of establishing a state-owned cement plant was defeated in the senate yesterday by a vote of 19 to 13. A similar measure offered by Assemblyman William C. Coleman, Milwaukee, was killed in the lower house some time ago.

Senator John Cashman, Denmark, opposed the bill, saying that a state owned plant would drive out the only cement plant in Wisconsin, at Manitowoc. Senator William A. Titus, Fond du Lac, also opposed the bill.

Another Blue Diamond Unit

Another Blue Diamond plant known as the Blue Diamond Company is now in operation in Birmingham, Alabama. The new company was organized by F. M. Taylor and Hayden Brooks, formerly with the Birmingham Slag Company. The plant has a capacity of 200 cubic yards of machine mixed mortar per day and especially equipped trucks are used for delivery.

The Consolidated Blast

A South Dakota Blast

The Consolidated Sand and Stone Company, successor to the Sioux Falls Sand Company and the Spencer Quarry Company of South Dakota, made an interesting blast in their quarry at Spencer, South Dakota, recently. This was a pit blast for the purpose of opening up a new face. Eight holes, 5½ inches in diameter and 30 feet deep, were drilled. Each hole was loaded with about 350 pounds of 60 per cent gelatin dynamite.

The material blasted was red quartzite very hard in character with comparatively few seams. The result was 9,000 tons of stone about 95 per cent of which was immediately ready for the crusher.

Illinois Central Encourages Use of Limestone

The Illinois Central Railroad, to encourage the use of limestone by farmers, is arranging to sell this material by the trainload and offers through Will Farlow, its agricultural agent, to deliver it at any point along its right-of-way in order to place it as near as possible to the land on which it is to be spread, thus reducing the cost of haulage to a minimum.

The Illinois Central Railroad is not doing this work or taking this added trouble for the purpose of selling lime, but because the company officials realize that for every ton of lime hauled to the farmers there will be an increase of fifty tons of farm products of various kinds to be shipped to market by the farmers who lime their land.

Results of Blast by the Consolidated Sand and Stone Company

Consolidated Sand and Stone Company Plant

Stone and Webster Buys Arizona Lime Plant

A report from Prescott, Arizona, states that the Puntenney Lime Company has been bought by Stone and Webster, of New York and Boston. The deal for the plant, kilns and quarries has been recently closed, according to John Sheffield, general manager of the Puntenney Company. The amount involved is said to have been $235,000. The purchasing company, it was announced, intends to make extensive improvements and enlarge the plant to a considerable degree.

Now Federal Gravel Company

A reorganization has resulted in the Federal Gravel Company succeeding the Federal Sand and Gravel Company of Saginaw, Michigan. The offices of the Federal Gravel Company are at 502 Eddy Building, Saginaw, and the officers include J. R. Sensibar, president; J. K. Swanson, vice president; Olive Owens, secretary, and B. F. Griffin, treasurer.

Blue Diamond Company Improves Screening

For the purpose of eliminating waste and obtaining a greater percentage of salable material from its gravel product, the Blue Diamond Company of Los Angeles, one of the largest producers of building materials in the world, is now installing two 5 ton scrubber screens of the latest type, reports C. H. Coll, production manager of the company.

These scrubber screens, which are to be used for washing and cleaning sand and gravel, have 40,000 holes in each of the 25-foot lengths, says Coll. They were manufactured in Los Angeles by the Standard Boiler and Steel Works, which company has furnished a good part of the machinery in the sand and gravel washing plant and plaster mill of the Blue Diamond plant.

With the old scrubber type of washer, the high sand content in the material caused the sand to act as a cushion and prevented particles of gravel from working against one another and washing out the dirt, declared the materials company production manager.

The new screens were installed for the purpose of taking out the sand in the first five or six feet of the passage of the gravel over this screen, thus permitting the remainder of the screen to act both as a scrubber and a screen eliminating the pea gravel.

After passage through the primary screen, the rock is discharged into double Gilbert screens, also furnished by the Standard Boiler and Steel Works, where the sizing is done," continued Coll. "Formerly with the old solid type of scrubbers, these Gilbert screens were forced to take the whole load of sand and gravel, whereas now they are handling gravel alone." It is estimated that the change has made for an improvement in the quality of the product of about 100 per cent.

Sandy Pratt's Company Expands Again

Clarence (Sandy) Pratt, president of the Pratt Building Material Company, and the Pratt Rock and Gravel Company, producers of sand, crushed rock and gravel, recently announced the purchase of two new pieces of property—one at Mayhew, on the American river, nine miles from Sacramento—the American River Sand and Gravel Company's sand, rock and gravel producing plant. This new property has rail connections and controls over a half-mile of land along the American river, and a deposit of over 2,500,00 tons of rock, gravel and sand is on the property. The other property is at Hoyt, Solano County, six miles from Benecia, where the Vulcan Rock Company formerly produced crushed rock. At the Hoyt property there is 5,000,000 tons of cementing road rock, used for state and county highway construction.

The latest expansions are the large sand, rock and gravel distributing bunkers at Berry and De Haro streets, in San Francisco, and on Riverside Drive in the southern part of Sacramento. The mammoth San Francisco bunkers, probably the largest sand, rock and gravel distributing bunkers in northern California, will hold thirty-two railroad carloads, over 1900 tons, or 3,840,000 pounds of material. The most modern equipment is being installed for the unloading of railroad cars and the re-loading into auto trucks for the retail trade of San Francisco.

The T. I. Butler Company, successors to the Pacific Gravel Company, will distribute Pratt's products from these San Francisco bunkers. At the Riverside Drive bunkers in the southern part of Sacramento, the Golden Gate-Atlas Materials Company will distribute Pratt's sand, rock and gravel. The Golden Gate-Atlas Materials Company now operate the Pratt Company's large distributing bunkers at 15th and A. streets in the northcentral part of Sacramento.

Besides the above properties the Pratt Company has sand, crushed rock and gravel plants at Sacramento, Marysville, Prattrock (near Folsom) and Prattco (Monterey County). Their central office is in San Francisco and Howard W. Senter is secretary and Clarence (Sandy) Pratt president of the four above companies.

C. S. Vance at Clinchfield

Charles S. Vance has been appointed assistant superintendent at the Clinchfield, Georgia, plant of the Pennsylvania Dixie Cement Corporation.

New Tennessee Cement Plant Now in Operation

At Cowan, Tennessee, it is reported, the Cumberland Portland Cement Company's new $2,000,000 plant is now in full operation, producing a type of cement which, after being tested under the regulations of the American Society for Testing Materials, is designated as a "super cement." The finished product is being stored in tanks and is being used principally in construction work about the plant.

The plant has a production capacity of 2,200 barrels daily, but at present only 750 barrels are being manufactured each day. Besides the regulation gray cement, the plant is one of the three in the United States capable of producing the highly valuable white cement.

The officers of the company are W. V. Davidson, president; J. R. Greene, vice-president; Ralph T. Miller, general manager, and Frank Pearson, assistant manager. The main offices of the company are located in Nashville.

Four Cement Companies Join In Huge Cement Bid

So great is the quantity of cement required for the San Gabriel flood control dam that no one of the great California manufacturers is able to supply it from present production schedule, it developed when bids were opened by the Board of Supervisors at Los Angeles and it was found that the four largest concerns had entered a joint bid.

This tender, the only one received, is for delivery of 2,600,000 barrels of bulk cement at a price of $1.77 per barrel, f. o. b. cars Crestmore or Colton, it being provided that if shipment is made from any other point the freight differential will be absorbed. At this price the cement called for in the specifications would cost a total of $4,602,000, plus freight.

An alternative bid at $2.22 per barrel for cement in sacks was submitted. At this price the total cost of cement would be $5,777,000. It is for the supervisors and their engineers to decide whether advantages in handling would offset the higher cost of sacked cement.

With the bid there was forwarded to the board a letter from the manufacturers setting forth that the reason they joined in a common bid was that the order was so large no one of them could guarantee deliveries at the rate called for without increasing plant facilities, and thus adding cost.

There was also submitted a copy of the four-company agreement, providing for selection of a trustee to collect and disburse funds received in payment.

The undertaking of each of the four companies is as follows: Riverside Portland Cement Company, 850,000 barrels; Southwestern Portland Cement Company, 500,000 barrels; California Portland Cement Company, 850,000 barrels; Monolith Portland Cement Company, 400,000 barrels.

Surety bond in the sum of $200,000 guaranteeing faithful performance, was offered with the bid. The bid was referred to Supervisor Graves for a recommendation.

Another New Lime Plant

Everett Saxon Company, of Everett, Pennsylvania, are to build a lime and hydrate plant consisting of three York coal fired kilns and a complete Schulthess hydrate plant with a capacity of 75 tons per day.

Superior Cement Supports Safety Campaign

The operating officials and workmen of the Superior Portland Cement Company, at Concrete, Washington, have started a Safety First campaign. To get the drive properly launched a rally was held at the Concrete Theater on a Saturday evening. Every seat in the theater was filled by Superior employees and members of their families, and the program was interesting and entertaining as well as educational. The rally started promptly at 7:15, Ole Nelson, chairman of the Safety Committee, presiding. Claude E. Hutchison, secretary of the company, read the rules and aims of the campaign now under way, after which General Manager Charles N. Heitze made a short talk on the value of eliminating accidents, pledging the company to do everything in its power to help the campaign and asking that every employee call the attention of the foreman or superintendent to any apparent defect in machinery or equipment so that it could be remedied before an accident occurred.

After inspiring addresses by John A. Kane, a Seattle attorney who is a director of the Superior Company, and John T. Hartman, a director of the International Cement Company, the showing of Lon Chaney's "Tell It to the Marines" closed the evening's program. Early in the following week the green and white safety pennant was raised to the top of the flagpole at the plant, and under the rules governing the campaign this will remain until a time-lost accident occurs in the plant or the quarry.

Distribution of Cement

Portland cement shipped from mills into States in April and May, 1926 and 1927, in barrels*

Shipped to	April 1926	April 1927	May 1926	May 1927
Alabama	215,372	173,893	184,774	164,359
Alaska	957	1,037	2,296	2,514
Arizona	40,257	47,573	37,717	46,724
Arkansas	62,646	53,331	64,713	77,207
California	850,124	1,137,845	1,165,540	1,281,461
Colorado	104,386	86,431	119,761	109,671
Connecticut	149,459	179,863	209,515	193,315
Delaware	48,259	40,699	38,972	35,564
District of Columbia	82,579	89,048	85,961	79,566
Florida	323,909	271,575	386,712	234,914
Georgia	171,829	168,681	186,398	209,126
Hawaii	27,999	25,876	13,705	25,631
Idaho	47,688	32,063	58,044	26,767
Illinois	961,612	956,012	1,671,317	1,402,964
Indiana	310,301	†418,874	†570,942	561,019
Iowa	219,716	†211,248	317,323	357,184
Kansas	204,165	203,368	259,208	294,596
Kentucky	141,326	†148,567	†188,486	188,319
Louisiana	99,889	107,023	96,519	116,352
Maine	33,345	39,031	51,441	49,870
Maryland	199,076	224,405	279,126	224,398
Massachusetts	298,326	293,606	362,878	289,218
Michigan	576,865	†857,574	†1,182,060	1,258,924
Minnesota	296,040	258,506	496,800	387,814
Mississippi	65,511	78,127	73,146	74,061
Missouri	505,850	312,311	696,773	409,889
Montana	23,063	23,882	23,832	24,561
Nebraska	170,591	96,255	190,275	155,964
Nevada	8,478	10,406	8,165	7,495
New Hampshire	37,909	43,932	46,559	38,333
New Jersey	653,779	879,645	770,730	894,457
New Mexico	15,861	28,566	12,004	31,149
New York	1,633,864	2,131,528	2,223,644	2,188,026
North Carolina	357,978	324,758	424,474	367,215
North Dakota	39,039	38,157	58,351	40,034
Ohio	674,151	†837,050	†1,200,619	948,788
Oklahoma	220,016	242,747	229,209	327,529
Oregon	126,874	122,281	127,318	152,050
Pennsylvania	1,243,762	†1,199,544	†1,614,063	1,331,265
Porto Rico	0	1,000	0	2,250
Rhode Island	64,303	78,743	96,407	77,876
South Carolina	49,573	82,680	58,544	87,442
South Dakota	43,693	35,465	61,899	38,442
Tennessee	178,683	180,574	201,130	217,416
Texas	411,203	472,879	431,778	545,848
Utah	35,218	31,793	†38,301	32,759
Vermont	14,358	30,185	28,202	29,715
Virginia	161,284	135,226	196,368	168,463
Washington	189,037	248,518	212,259	223,574
West Virginia	154,310	†112,009	†217,546	141,521
Wisconsin	277,248	356,961	537,441	568,828
Wyoming	13,887	14,783	17,558	17,531
Unspecified	57,493	102,398	†70,063	40,626
	12,893,141	14,296,532	†17,896,866	16,800,584
Foreign Countries	71,859	53,468	76,134	58,416
Total shipped from cement plants	12,965,000	14,350,000	17,973,000	†16,859,000

*Includes estimated distribution of shipments from three plants in April and May, 1927; from four plants in April, 1926; and from five plants in May, 1926.
†Revised.

Production, shipments, and stocks of finished Portland cement, by districts, in June, 1926 and 1927, and stocks in May, 1927

Commercial District	June Production 1926	June Production 1927	June Shipments 1926	June Shipments 1927	Stocks at end of June 1926	Stocks at end of June 1927	Stocks at end of May 1927*
Eastern Pa., N. J. & Md.	3,956,000	4,091,000	4,629,000	4,745,000	3,967,000	4,394,000	5,048,000
New York	890,000	1,009,000	1,081,000	1,262,000	1,227,000	1,420,000	1,673,000
Ohio Western Pa. & W. Va.	*1,665,000	1,716,000	*2,051,000	2,162,000	*2,310,000	2,953,000	3,400,000
Michigan	1,430,000	1,580,000	1,614,000	1,804,000	1,734,000	1,971,000	2,195,000
Wis., Ill., Ind., & Ky.	*2,397,000	2,387,000	*2,873,000	3,086,000	*2,980,000	2,432,000	3,131,000
Va., Tenn., Ala., Ga. & La.	1,468,000	1,414,000	1,411,000	1,357,000	1,125,000	1,203,000	1,146,000
Eastern Mo., Ia., Minn. & S. D.	1,545,000	1,467,000	*1,946,000	1,927,000	2,417,000	2,829,000	3,289,000
Western Mo., Neb., Kan. & Okla.	1,129,000	994,000	1,105,000	976,000	1,454,000	1,743,000	1,725,000
Texas	416,000	469,000	454,000	454,000	478,000	330,000	314,000
Col., Mont., Utah.	311,000	268,000	289,000	233,000	369,000	551,000	516,000
California	1,281,000	1,315,000	1,305,000	1,294,000	502,000	594,000	573,000
Ore. & Wash.	378,000	368,000	376,000	416,000	437,000	424,000	472,000
	16,866,000	17,078,000	19,134,000	19,716,000	19,000,000	20,844,000	23,482,000

*Revised. †Began producing June, 1927.

Domestic hydraulic cement shipped to Alaska, Hawaii, and Porto Rico, in May, 1927*

	Barrels	Values
Alaska	2,970	$ 9,061
Hawaii	32,028	68,569
Porto Rico	6,045	14,746
	41,043	92,376

*Compiled from the records of the Bureau of Foreign and Domestic Commerce and subject to revision.

JUNE CEMENT STATISTICS

Shipments of Portland cement in June are the greatest for any month in the history of the industry, and production for the month is slightly under and second only to that of July, 1926, according to the Bureau of Mines, Department of Commerce. Portland cement stocks show a seasonal decline but are nearly 10 per cent greater than the stocks at the end of June, 1926.

Production and shipments of Portland cement for the first half of 1927 show increases respectively of over 4 and 5 per cent over the corresponding period in 1926.

The output of another new plant, located in Louisiana, which began operating in June, is included in these statistics, which are prepared by the Division of Mineral Statistics of the Bureau of Mines and are compiled from reports for June, 1927, received direct from all manufacturing plants except two, for which estimates are necessary on account of lack of returns.

New Incorporations

Electric Limestone Co., Arcade Bldg., E. St. Louis, Ill. 1,000 shares n.p.v. (Delaware.)

Clearwater Sand & Shell Co., Inc., Clearwater, Fla. $25,000. A. H. Zimmerman, Ed. N. Eaton.

Federal Graphite Co., Anniston, Ala. $100,000. John D. McCullough, John Lewis, First National Bank Bldg. W. L. McCullough, all of Birmingham.

Pennsylvania Glass Sand Corp. $15,000,000. A. J. Fink, Citizens' Nat. Bank Bldg., Baltimore, Md., chairman of board; Addison E. Mulliken, Citizens' National Bank Bldg., and Henry P. Bridges, both of Baltimore, also members of board of directors. To acquire entire properties and assets of Pennsylvania Glass Sand Co. and physical properties of Maryland Glass Sand Co., Inc., Berkeley Glass Sand Co., E. F. Millard Sand Works, West Virginia and Pittsburgh Sand Co., and Pittsburgh White Sand Co. of West Virginia. Properties to be acquired by company are in the Oriskany Vein, West Virginia.

Florida Lime Rock Sales Corp., Ocala, Fla., $50,000. G. G. Ware, E. F. Fitch, W. M. Palmer.

National Sand & Gravel Co., Omaha, Nebr. $50,000. David Swarr, E. A. Poyce.

Putnam Sand Co., St. Augustine, Fla. $10,000. E. N. Calhoun, Gertrude E. Calhoun, James P. Clark.

Capital City Sand & Gravel Co., Tallahassee, Fla. $200,000.

Baas Rock Co., Inc., Miami, Fla. 100 shares, p. v. $100 each. John H. Baas, 335 Southwest 12th Ave.; M. E. Turner, C. F. Turner.

Keystone Rock Co., 75 Macon Ave., Ashville, N. C. $100,000. John N. Bohannon, Mary E. Bohannon, Jay D. McGahey. To quarry rock.

Superior Cement Co., Jackson, O.

Oliver C. Putney Granite Corp., Arbutus, Md. Oliver C. Putney, Frank C. Atherton, Claude E. Watson.

Kern Marble Co., Knoxville, Tenn. $24,000. Chas. M. Kern, Robert A. Kern, Margaret D. Kern.

Midwest Sand & Gravel Co., 201 N. Junction St., Muskogee, Okla. $250,000. J. A. DeWitt, Muskogee; R. W. Keller, 231 S. La Salle St., Chicago; O. E. Winzer, 1220 N. Dearborn St., Chicago.

Enid Sand & Gravel Co., Bank & Trust Bldg., Enid, Okla. $50,000. O. C. Calvert, J. L. Neuner, Ed. Fleming.

Howard Material Co. (Illinois corporation) Capital stock in Indiana, $3,900. Agent and Indiana office, Jacob C. Rothenberger, Miller, Ind. Produce sand and gravel.

Rostone, Inc., Lafayette, Ind. $100,000. David E. Ross, Pres.; Prof. H. C. Peffer, V. P.; Richard L. Harrison, Sec.-Gen. Mgr. To manufacture building stone from their shale deposits.

General Marble Co., 1948 Ridge Ave., Evanston, Ill. Alfred Golassini, Lawrence Joseph and Christie Vivirito. (Cor., Milton A. Kallis, 134 N. La Salle St., Chicago.)

Uncommon Manganese Deposit

The presence of manganese minerals on the eastern and southern borders of the Olympic Mountains, Washington, was known as early as 1912, when they were recognized in some copper prospects, but their possible value as a source fo manganese only became evident during the World War. Attempts were made to work the deposits but were unsuccessful because the only materials that could be found contained too much silica to permit their conversion into alloys of acceptable grade. These deposits, which are known to be large, may yet become an important resource if the silica can be eliminated.

Since the war, however, prospecting along the north slope of the mountains has led to the discovery of several deposits, one of which near Lake Crescent has yielded in three years about 17,000 tons of ore containing more than 52 per cent of manganese and less than 9 per cent of silica, probably the largest concentrated body of this grade that has yet been found in the United States.

Production, shipments, and stocks of finished Portland cement, by months, in 1926 and 1927

Month	Production 1926	Production 1927	Shipments 1926	Shipments 1927	Stocks at end of month 1926	Stocks at end of month 1927
January	7,887,000	8,258,000	5,674,000	5,968,000	20,582,000	22,914,000
February	7,731,000	7,377,000	5,820,000	6,731,000	22,385,000	23,560,000
March	10,390,000	11,452,000	9,539,000	11,083,000	23,236,000	23,922,000
1st quarter	26,008,000	27,087,000	21,033,000	23,782,000	.....	.....
April	12,440,000	14,048,000	12,965,000	14,350,000	22,710,000	23,654,000
May	16,510,000	16,674,000	17,973,000	*16,859,000	21,255,000	*23,482,000
June	16,866,000	17,078,000	19,134,000	19,716,000	19,000,000	20,844,000
2nd quarter	45,816,000	47,800,000	50,072,000	50,925,000	.....	.....
July	17,134,000	.....	18,812,000	.....	17,301,000	.....
August	16,995,000	.....	18,583,000	.....	15,718,000	.....
September	16,571,000	.....	18,087,000	.....	14,188,000	.....
3rd quarter	50,700,000	.....	55,482,000	.....	.....	.....
October	16,596,000	.....	17,486,000	.....	13,334,000	.....
November	14,193,000	.....	11,276,000	.....	16,243,000	.....
December	10,744,000	.....	6,432,000	.....	20,616,000	.....
4th quarter	41,533,000	.....	35,194,000	.....	.....	.....
	164,057,000	.....	161,781,000	.....	.....	.....

*Revised.

Exports and Imports*

Exports of hydraulic cement by countries, in May, 1927

Exported to—	Barrels	Value
Canada	2,695	$ 12,701
Central America	8,045	22,814
Cuba	10,261	26,408
Other West Indies and Bermuda	7,521	17,412
Mexico	9,766	36,753
South America	17,977	71,257
Other countries	3,067	18,229
	59,332	$205,574

Imports of hydraulic cement by countries, and by districts, in May, 1927

Imported from—	District into which imported	Barrels	Value
Belgium	Florida	$ 19,800	$ 29,606
	Georgia	5,000	6,871
	Massachusetts	49,128	62,272
	New Orleans	4,069	5,051
	Oregon	8,960	11,779
	Philadelphia	43,503	61,614
	Porto Rico	7,500	15,236
	Sabine	5,000	10,000
	San Francisco	8,349	10,260
	Total	$151,309	$212,689
Canada	Saint Lawrence	1,525	3,268
Denmark and Faroe Islands	Porto Rico	16,170	25,489
France	New York	2,107	4,762
Germany	Maryland	.....	5
United Kingdom	Los Angeles	1,000	3,069
	Maryland	500	804
	Massachusetts	4,336	6,969
	New York	1,732	5,984
	Philadelphia	250	579
	Total	7,818	17,405
	Grand total	$178,929	$263,618

Exports and imports of hydraulic cement, by months, in 1926 and 1927

Month	Exports 1926 Barrels	Exports 1926 Value	Exports 1927 Barrels	Exports 1927 Value	Imports 1926 Barrels	Imports 1926 Value	Imports 1927 Barrels	Imports 1927 Value
January	72,939	$ 216,431	75,346	$254,072	360,580	$ 576,717	193,175	$269,661
February	73,975	220,706	71,404	233,985	314,118	527,948	130,421	200,680
March	69,080	205,647	67,956	240,165	493,241	812,968	181,145	261,519
April	96,296	284,772	72,383	243,832	257,302	398,114	191,868	313,262
May	78,601	224,365	59,332	205,574	223,130	337,031	178,929	263,618
June	80,684	248,814	.....	.....	335,570	495,744	.....	.....
July	130,822	370,220	.....	.....	250,862	395,981	.....	.....
August	64,946	216,489	.....	.....	350,628	560,532	.....	.....
September	70,920	239,174	.....	.....	194,129	308,224	.....	.....
October	69,389	225,874	.....	.....	263,403	386,335	.....	.....
November	76,598	238,103	.....	.....	55,233	82,949	.....	.....
December	89,976	305,238	.....	.....	151,850	246,293	.....	.....
Totals	974,226	$2,995,833	.....	.....	3,250,056	$5,128,936	.....	.....

*Compiled from the records of the Bureau of Foreign and Domestic Commerce and subject to revision.

Serpentine to be Quarried In North Carolina

Opening of a serpentine quarry shortly in Ashe County, North Carolina, only a few hundred feet from the soapstone finishing mill of the Virginia-North Carolina Soapstone Company, will mark the first time that deposits of this material have been worked commercially in the state, according to a report by State Geologist H. J. Bryson.

The deposit, described by engineers as being of large proportions, will be worked for decorative stone. Analyses of specimens shows a material similar to the commercial deposits found elsewhere in America, as well as in Europe.

Pure serpentine is a hydrous silicate of magnesia but it is rarely pure, usually containing hornblende and carbonates of lime and magnesia. It is a rock of dull to waxy luster, generally compact and with a splintery to smooth fracture. The general color is green, characteristically a yellowish green, but sometimes yellow, yellow-brown, and dark green to black. The predominating color in the newly discovered deposit in Ashe County is grayish green to dark green, somewhat spotted with white minerals.

Several counties of North Carolina have reported deposits of serpentine, none of which, however, have been worked commercially heretofore.

Union Talc Plant Changes Increase Production

The Union Talc Company, with mills and mines near Gouverneur, N. Y., have made some plant changes to increase production. They are running between 75 and 100 tons of talc per day and manufacturing about the same amount. The finished material is used largely among the paper and paint manufacturers. The mills are located on the New York Central lines with convenient shipping facilities.

Herzog May Buy Another Plant

According to a report from Tiffin, Ohio, negotiations are about completed for the sale of the stone and lime plant of the Consumers Lime Company, on the eastern edge of the city, to John Herzog, of Forest. The plant, one of the important industries, has been closed pending consummation of the deal. The output is a high grade of lime that is practically all absorbed by glass manufacturers. Mr. Herzog operates a similar plant at Patterson, near Forest.

Irving Warner Injured

Irving Warner suffered an accident at the Cedar Hollow plant while inspecting some hoisting machinery. He caught his foot between a flange on a hoisting drum and the steel frame, breaking two toes and bruising his foot.

C. P. Watkins Passes

From Seattle, Washington, comes the report of the death at the Columbia Hospital in that city, at the age of 61, of Carlos P. Hopkins, field engineer of the Portland Cement Association and prominent in the Pacific Northwest good roads movement. The funeral services were held at the Bonny-Watson Company's mortuary on the afternoon of July 1.

Another Company Electrified

The Higginson Manufacturing Company operates mills at Newburgh, N. Y., and quarries at Windsor, Nova Scotia. They manufacture calcined finishing plaster, wall plasters, agricultural gypsum, dental plasters, terra alba and whiting. Their plants are now totally electrified.

Mississippi Flooded Plant Resumes Operations

From Estill Springs, Tennessee, comes the report that operation of the plant of the Cumberland Sand and Gravel Company has been resumed, after a shutdown of several months caused by the recent high waters, which completely washed away the company's railroad bridge and did other damage to the plant. A spur track from Estill Springs to the main plant of the company has been put down, and a new plant for washing and screening is being erected. The daily output will be about thirty cars. The company's main offices are located at Nashville.

Finishing Specifications for Lime Plaster

The Finishing Lime Association of Ohio has just issued, as Bulletin 400, and arranged in a form suitable for filing, a complete set of standard specifications for finishing lime plaster. The materials specified, besides finishing hydrated lime, include sand for scratch and brown coats, sand for sand finish, colored screenings and marble dust for coloring, plaster of paris, Keene's and portland cement for gauging, hair and vegetable fiber, water, wood and metal lath. The specifications in detail cover dry mix and putty mix base coats on concrete surfaces, dry mix and putty mix three coat work on metal lath and on wood lath, dry mix and putty mix two coat work (doubled up) on wood lath, and dry mix and putty mix (doubled up) on brick, tile, gypsum block, concrete block, etc.; also finish coats. Some valuable notes on finishing lime plaster and white finish are also given.

Phoenix Treats Customers

The Phoenix Portland Cement Corporation served chicken dinner on the lawn in front of the plant office in Birmingham, Alabama, to engineers, contractors and architects of Birmingham recently. The dinner was preceded by an inspection trip through the plant.

Super Cement

Super Cement is not new. We are informed that it was originally perfected in England and has been used in that country for over twelve years. During the Great War the details of its manufacture and total output were controlled by the British Government. They employed it in much of their war-time construction work for varied uses including gasoline reservoirs, aerodromes, etc.

In 1920 it was introduced into Canada and subsequently into the United States. Super Cement is now manufactured and marketed by three companies in the U. S. under license from the Super Cement Company. This product, which is mixed and used the same as portland cement, serves a definite need—it produces impermeable concrete.

The chief limitation of concrete is its porosity and its consequent inability to withstand exposure to intermittent moisture and to certain chemical agencies. It was to overcome this shortcoming that Super Cement was developed.

Super Cement should not be confused with waterproofing compounds or supplementary waterproofing treatments. It is a cement which, by virtue of its own inherent qualities, produces concrete that is waterproof absolutely.

Its economical use is not limited to dams, swimming pools, reservoirs, etc. where a watertight job is essential, but it also covers the wide field of permanent work that must be exposed to wear, weather, frost, sulphur waters, organic acids and other destructive agents.

In addition to making possible a concrete that is waterproof absolutely in a most practical and economical way, it also affords uniform texture, high strength and unusual resistance to wear. Increased workability and plasticity are also characteristic features of this cement. The Marquette Cement Manufacturing Company is now manufacturing super cement.

NEWS OF EQUIPMENT MANUFACTURERS

General Excavator Issues Descriptive Folder

An attactive folder in two colors, just issued by the General Excavator Company, brings out in succinct text and clear illustrations the outstanding merits of the General excavator as an efficient clamshell, dragline, crane with hook block, power shovel, trencher and skimmer, or backfiller. The General is a powerful, rugged, flexible machine with full half-yard capacity. Almost 90 per cent of its weight is alloy steel castings, and 90 per cent of the bearings are bronze bushed. Its operating machinery is mounted on a single massive cast steel foundation. The shafts are turned from hot hammered alloy steel. The large wide faced swing gear has external teeth cut from a solid block, and the roller path is wide and broad. It is full revolving and its cab is fully enclosed. Changes can be made in the field from one use to another without the addition of any operating machinery.

Hayward Issues House Organ

"Bucket Pick-ups" is the title of the new house organ of the Hayward Company, number one of volume one of which has just made its appearance. The main purpose, the company announce in their salutatory, is "to pick up and distribute all the interesting facts we can scrape together about the use of Hayward buckets." Incidentally they evidently intend also to make their publication of educational value, judging from the two well written serial articles of historical interest appearing in the first number, one of these being "The Roman Aqueducts," beginning a series on great construction projects, and the other the first installment of "Lifting the Burdens of Industry," by Raymond Brennan.

Climax Issues Parts Books

The Climax Engineering Company, Clinton, Iowa, have just issued a series of booklets 8½x11, averaging forty pages each, containing parts price lists and operation instructions for their Models R6U, R4U, and TU engines and power units.

Each of these books contains detailed lists of parts wtih illustrations of each part, complete instructions for the care, operation and adjustment of each engine as well as other pertinent information which might be needed by the user of Climax engines.

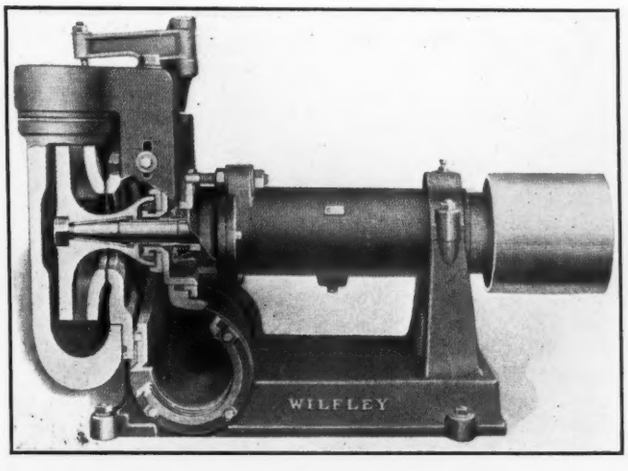
The Wilfley Pump

Catalog number 6, issued by A. R. Wilfley & Sons, illustrates in detail the mechanical construction of the Wilfley centrifugal sand pump and its application to the cement and sand and gravel industries for handling slurry and wash mill clay in wet process plants; for kiln feeding; for transferring slurry from grinding 5138 Pit & Quarry 7-13 Madigan mills, storage tanks, mixing basins; general handling of sands, disposal, reclaiming, and as a booster pump in dredging.

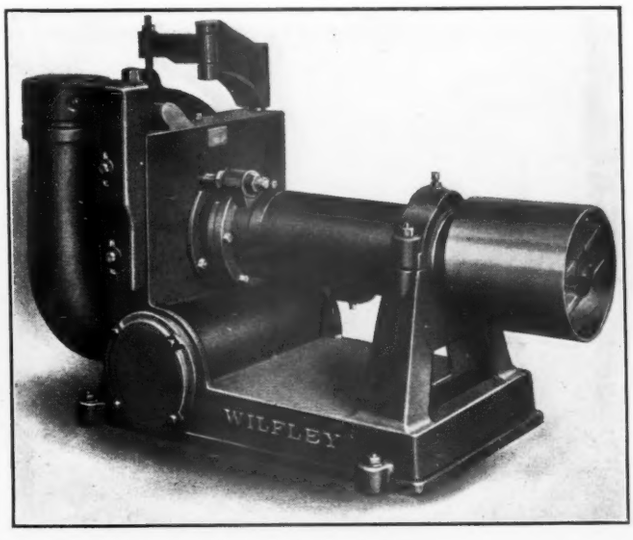
The distinguishing feature of this pump is the patented centrifugal seal, which eliminates stuffing box troubles by doing away with the stuffing box, and which makes it especially adapted for pumping gritty materials even up to 70 per cent solids. The seal, by eliminating wear on the shaft, also makes practical the proper mounting of ball-bearings. It opens the intake chamber to the air so that the pump can have no suction but must be set below the supply, allowing the material to be pumped to flow in by gravity. This prevents air being trapped in the runner and thus enables the pump to deliver an uninterrupted uniform stream. It also lessens the tendency for pipes to clog, does away with excessive peak loads, and reduces the tension on the belt.

The Wilfley seal consists of a revolving member, called the "expeller," which has wings or paddles radiating from a recess in its center to its periphery, and a stationary member with a projecting groove. In action the material pumped is prevented from leaking out by the centrifugal motion of the expeller wings, similar to that of an open runner, and any slippage by the side is caught by the projecting groove and delivered to the wings. An automatic check valve seals around the shaft while the pump is not in operation.

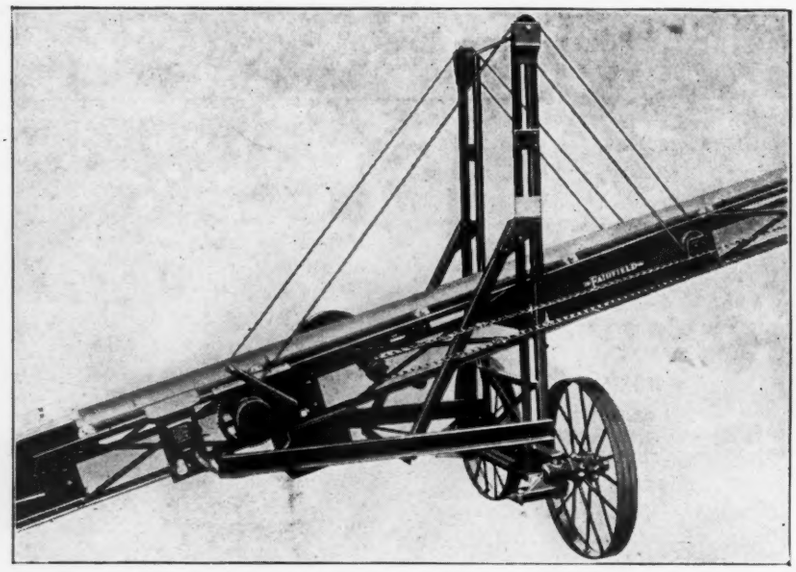
One of the greatest losses in a centrifugal pump is the slippage of the material handled from the discharge back to the intake of the runner. This causes a loss of capacity. The wearing of the sand or grit causes an enlargement of the clearance, necessitating frequent renewals of the wearing parts unless an adjustment is provided. The Wilfley seal provides a simple practical take-up adjustment which may be made in a few moments while the pump is in operation. This slippage seal adjustment, combined with the use of ball bearings, the absence of rubbing contact while in operation and the use of long-life wearing parts, makes for great efficiency. It also makes possible the pumping of sand and grit against heads, as well as easy adjustment and installation of wearing parts, and eliminates the necessity of overspeeding.



Sectional View of Model "C" Wilfley Pump



Wilfley Centrifugal Pump



Fairfield Portable Belt Conveyor

Portable Belt Conveyors

The Fairfield Engineering Company, in Bulletin number 65, illustrate the Fairfield portable belt conveyor, designed to produce a machine that would render as satisfactory service in the handling of sand, gravel and crushed stone as the Fairfield flight conveyor has rendered in the handling of coal. Three-pulley steel troughing idlers with wide rubber-covered belt are used in this conveyor—a type universally approved for the handling of abrasive materials, reducing the power requirements and wear on the belt to a minimum, while the capacity of the trough is unusually large. To secure ample capacity, 20-inch belts are standard equipment on these conveyors in lengths up to 35 feet, and 24-inch on longer conveyors. These lengths insure ample capacities without the use of sideboards, the elimination of which avoids damage on the edges of the belt, increases the life and service and materially decreases the cost of maintenance. The belts have an extra heavy rubber cover on the carrying side and an extra ply of canvas around each edge.

The three-pulley idlers are made of steel. The bearings have renewable bronze bushings, grease reservoirs and alemite fittings. The head pulley, a crowned-face split pulley, of pressed steel, mounted in a unit take-up frame, is easily adjusted, by setting up a single adjusting screw on each side, for removing slack in the belt. A flared receiving hopper of steel is provided to protect the belt and to center the load, and rubber strips are attached to the edges of the hopper plates to prevent cutting of the belt. The steel foot plate is of the pull-out type and can be removed instantly when desired. Three straight steel rollers are mounted 12 inches apart at the foot end to sustain the weight of heavy loading. The inner side of the foot-pulley is provided with a steel wiper to clean off wet sand between the belt and pulley.

New Chain Belt Catalog

Chain Belt Company has just issued catalog number 220, "Rex Chains and Transmission Equipment," as a supplement to their general catalog number 210, entitled "Rex Chains and Conveyors." The new catalog contains revised list prices, chain weights and dimensions, and also lists and illustrations of new chains, sprockets and other items developed since the publication of catalog number 210.

Rex chain is made from certified malleable iron, assured by the American Malleable Castings Association to have been made in strict accordance with the highest standards in malleable iron production. It is certified to be uniformly high in strength, toughness and dependability. With this endorsement by metallurgical experts the user of sprocket chain need not depend upon chances.

Armstrong Company Appoints

The Armstrong Manufacturing Company announces the appointment of R. E. Boggs as distributor of Armstrong blast hole and water well drilling machinery in Alabama and Georgia, with headquarters at Birmingham. Mr. Boggs is a practical engineer thoroughly familiar with quarrying and blasting and has a wide acquaintance among quarry operators and cement men in the territory to which he is assigned.

New Line of Solenoids

A new line of solenoids now on the market includes both alternating and direct current types and has been designed especially for uniformity and flexibility. These are made in all voltages and frequencies up to and including 550 volts, and nearly all the different types vary from each other in size only. This line is announced by the General Electric Company, and has been given the designation CR-9503.

Each size of solenoid has four types made up with the same frame. This allows any solenoid to be adapted to a variety of applications. An a-c. solenoid can be adapted for d-c. operation by simply changing coils and adding a cutout switch for which all frames are drilled. A pulling solenoid may be changed to a pushing solenoid by adding two standard pusher bars. The pole face of the plunger is cylindrical and fits into a cylindrical seat on the frame. This insures quiet operation in any position.

All coils are wound on moulded compound spools, which eliminates the possibility of grounds. Bakelite guides prevent the plunger from wearing the spool body. The coils are held in the correct position by springs which prevent any vibration.

Foote Appoints

Foote Bros. Gear and Machine Company announce they have recently completed arrangements with the Briggs-Shaffner Company, Winston-Salem, North Carolina, as district representatives on IXL speed reducers and gear products for the state of North Carolina.

Mr. G. W. Craighead has recently been appointed district representative and will cover the eastern half of the State of Michigan with headquarters at 4-230 General Motors Buildings, Detroit, Michigan.

Mr. A. H. Tischer, formerly of the development engineering department, has been transferred to the sales organization and is now covering territory in the city of Chicago, south of Thirty-ninth street. He is also covering suburbs and the steel district in South Chicago and Northern Indiana.

Arrangements have been completed for the handling of IXL speed reducers and gear products in the northern half of the State of Oklahoma by the Circle Corporation, P. O. Box 1224, Tulsa, Oklahoma.

The Houston Armature Works of Houston, Texas, have been appointed as local representatives in that vicinity. They will operate under the jurisdiction and direction of the Dallas representative, Geo. J. Fix Company, 2507 Commerce street.

Method of Measuring a River

To ascertain the velocity of the stream choose a place where the channel is straight for 100 or if possible 200 feet and where it has a nearly constant width and depth and smooth current. Lay off on the bank the center 50 or 100 feet of the straight reach of the stream, marking each end. Then allow small chips to float down the stream, noting the time required for this to traverse the distance laid off on the bank.

The surface velocity in feet per second is obtained by dividing the distance in feet passed over by the chips by the time in seconds it takes them to travel this distance. The average result of several such tests, made at different positions from bank to bank, will give the mean or average surface velocity of the stream. This result multiplied by 0.8 gives very nearly the average velocity of the entire flow of the stream. This is the first step.

To obtain the area of the cross section of the stream, stretch a tape from shore to shore and take the depth of stream at short intervals—2 or 5 feet. The average of these depths may be assumed as the average depth of the stream at this point. This average in feet multplied by the total width in feet will give the area of the cross section of the stream in square feet.

The volume of the discharge of the stream is now found by multiplying this cross-section figure by the average velocity, feet per second, as obtained by the chip measurements, the result being the discharge in second-feet, or, in other words, the number of cubic feet of water flowing past the point of measurement each second.

Graphite in 1926

The graphite industry on the whole was more productive in 1926 than it was in 1925, according to a statement by the United States Bureau of Mines, Department of Commerce. The following statistics on production were collected in cooperation with the geological surveys of Alabama, Michigan, and Texas: The sales of natural graphite by producers in 1926 were 5,145 short tons, valued at $209,592, an increase of 480 tons, or 10 per cent, in quantity, and of $113,231, or 118 per cent, in value, compared with 1925. The increase was in the crystalline variety, amorphous graphite decreasing in both quantity and value. The 1926 sales of amorphous graphite amounted to 2,650 short tons (52 per cent of the total graphite), a decrease of 886 tons, or 25 per cent, compared with 1925. The value of the amorphous graphite in 1926 was $30,750, a decrease of 22 per cent compared with 1925. The sales of crystalline graphite in 1926 were 4,989,200 pounds, valued at $178,842, an increase of 2,731,950 pounds, or 121 per cent, and of $122,121, or 215 per cent, compared with 1925. The quantity and value of crystalline graphite in 1926 were the largest since 1920.

The manufacture of artificial graphite in New York increased considerably—from 12,135,655 pounds in 1925 to 21,163,986 pounds in 1926, or 74 per cent. The imports of graphite in 1926 amounted to 16,166 short tons, valued at 921,233, compared with 17,768 tons, valued at $826,410, in 1925.

One of the New Miami Models

Pennsylvania Appoints

The Pennsylvania Pump and Compressor Company has appointed P. I. Perkins Company of Boston, Massachusetts, representative in the Boston territory.

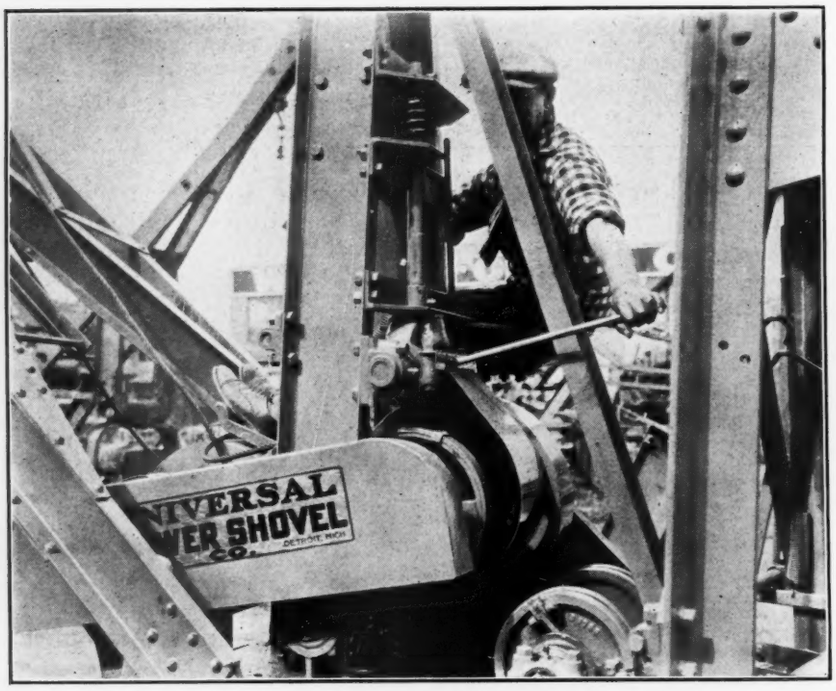
Miami Scraper Announce Two New Models

Up to the present the Miami on man power scraper has been manufactured only for the Fordson tractor. A demand for this unit in connection with other makes of tractors has led the Miami Trail Scraper Company to bring out two new models. Now this unit is available for use in connection with the 10-20 McCormick Deering and the 2 ton caterpillar tractor.

The Miami one man power scraper is a very flexible piece of equipment. It can be placed in the most difficult position for both loading and dumping. The scoop pan is always under the control of the operator. The control is positive through the Miami power winch which is furnished with each scraper.

All the important features in the Fordson unit have been incorporated in the two new units. The capacity of the pan in the new units has been increased to a full ¾ yard.

Another New Miami Model



Wilford Power Control

Wilford Improves Shovel

During the past two years the Universal Shovel Company has made several improvements on the original design of the Wilford power shovel. It was found that the Fordson power plant developed sufficient power in actual service to warrant the increase of the boom length from 13 to 15 feet and the dipper stick from 8 to 10 feet as standard equipment. New clutches have also been developed which are powerful and smooth in action and which require practically no attention. The latest improvement, just perfected by the company's own engineering department, is a power boom hoist for use on the Wilford crane, clamshell, dragline and backfiller. This is driven through a worm gear controlled by a bend-gear differential. There are two levers, the first of which engages the boom hoist differential mechanism, and a short throw to the right or left of the second lever automatically raises or lowers the boom. It is self-locking and constitutes a feature not usually found except in the larger units.

Ingersoll Rand Opens New Branch Office

To provide better sales and service facilities for its customers in Northern New Jersey and certain adjacent counties of New York State, Ingersoll Rand Company has opened a branch office at 236 High Street, Newark, New Jersey. Mr. F. K. Armstrong, formerly connected with the company's New York sales branch, has been appointed manager.

Cast Steel Shovel Chain Explained in Circular

National Malleable and Steel Castings Company has just issued Circular number 89, descriptive of their NACO cast steel steam shovel chain. This chain is made, in sizes from 1¼ inch to 1¾ inch, from NACO steel by a process exclusive to this company. Each link is cast in one solid piece in a sand mold made from standard patterns. Every link is therefore uniform in size, shape, weight and wire gauge diameter, and there are no welds or other weak spots to break or shorten its life. This careful and accurate method results in a free-running, easy handling chain that helps to keep steam shovels in operation and guard against costly breakdowns and delays. Comparative proof test figures are given.

Kent Machine Company Moves

As was intended at the time of purchasing the Falls Clutch and Machinery Company, of Cuyahoga Falls, Ohio, the Kent Machine Company has moved its entire factory and general offices from Kent, Ohio, to Cuyahoga Falls, and will now have its foundry, machine shop, warehouse and general office all in one plant. In addition to the Falls line of transmission machinery, the Kent Company manufactures a complete line of concrete products machinery, sold under the trade name "Red Line," a complete range of second operation machines for work on screw products, and a line of conveying equipment which includes all modern devices for material handling.

New Portable Air Compressor

The Pennsylvania Pump and Compressor Company, in bulletin 121, announce the Pennsy-Portable air compressor, in which the compressor and engine are combined into one unit, the four power cylinders and the two air compressor cylinders being mounted on a single crank case containing the six-throw crank shaft. The design is similar to the modern six-cylinder automobile engine except that the throws of the crank shaft, instead of being at 60 degrees, are properly located for the correct operation of the engine and compressor. This type of construction makes a very compact, rigid machine, without clutch or coupling, the power from the gas cylinders being applied directly to the air compressor through the single crank shaft.

Agrabatchers Described

The Heltzel Steel Form and Iron Company is sending out an interesting folder illustrating and describing the Heltzel portable bin and the Heltzel measuring and weighing agrabatchers. The trailer bin is made in four sizes, 35, 55, 80 and 110 tons, and of reinforced riveted steel construction throughout. The 35 and 55-ton bins can be shipped, trailed and erected in one piece, and, if the foundation is prepared, will be in operating position in fifteen minutes after reaching the job. The 80 and 110-ton bins are shipped in two sections, each section completely assembled with batchers in position. They can be completely erected or dismantled in three hours.

The Heltzel volume agrabatchers are operated by either wheel control from platform or by lever from the ground. They are interchangeable. The same frame and bolt holes are used for attaching either weighing or measuring agrabatchers, and all types can be attached to any make of bins, wood or steel.

New Pump Catalog Issued

The Worthington Pump and Machinery Corporation has issued Bulletin No. W613 on Worthington high-efficiency centrifugal pumps. These pumps have efficiencies of from 8 to 10 points higher than the average centrifugal pump. The bulletin describes the new pumps in detail. It also tells how 10,000 pump inquiries were analyzed to determine the heads and capacities most commonly specified by pump users. With this analysis as a basis Worthington engineers set about designing new lines of high efficiencies especially for those heads and capacities most commonly specified by users.

New Anti-Friction Idler

Link-Belt Company announces the introduction of a new anti-friction belt conveyor idler and return rolls of an advanced type of belt conveyor equipment embodying many advantages in design which are the result of years of study.

The bearings are Timken tapered roller bearing type and are entirely encased within the roll hub. The outstanding feature of the idler is the protection afforded by a labyrinth grease seal, mounted in a grease cup which also serves as an outboard reservoir and lubricates on the outside as well as the inside, especially when the roll is on the incline. A deflector plate deflects dirt, dust or any foreign material away from the grease seal and also prevents the washing away of the grease from the labyrinth.

The rolls are mounted on a self-cleaning T base, and are all interchangeable, being capable of serving in any of three positions. The entire frame is riveted and without nut or bolt to work loose or come out of adjustment. Special care is exercised in machining the roll shell to obtain uniformity. The design of the roll is such as to make it practicable to vary the characteristics of the metal used for the shell. For instance, a special iron has been developed for use in coke plants that resists the corrosive action of sulphuric fumes and the abrasiveness of coke dust. Rolls have also been granitized for the handling of materials that cause incrustation, pitting and rusting of ordinary steel or iron.

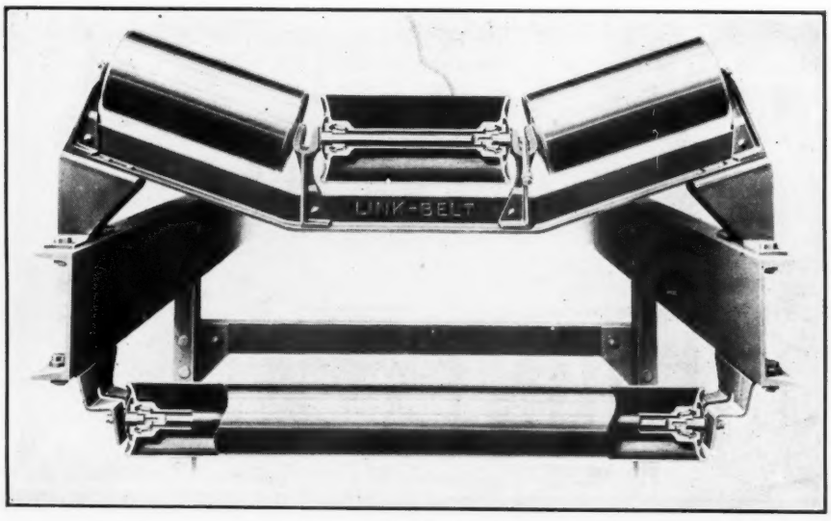
Rolls are spaced far enough apart to permit easy removal from the frame without the use of tools. They are made in various standard lengths and are furnished in combinations to suit standard belt widths. The end stands are securely riveted to the iron T base and are spread at the foot to afford a rigid support for the idler.

Marion Type 7 Shovel

Marion Type 7 Shovel Described

The Marion Steam Shovel Company is sending out three interesting booklets describing the Marion type 7 shovel, dragline and crane as provided with three different forms of motive power. Bulletin 318 shows this machine as operated by steam; bulletin 319, as operated by gas-electric power, and bulletin 320, as furnished with straight gas equipment. The type 7 Marion, although its tonnage is only about the same as its famous predecessor, type 21, has a full one-yard capacity with no reduction in speed, no increase in maintenance cost, and no addition to the working crew over the ¾-yard machine. It can be loaded on a shovel truck and moved anywhere. It will clear the same bridges, viaducts and wires under which the ¾-yard shovel has passed. Its parts are, of course, made stronger, to provide for the increased load due to the larger dipper, but it is more compact and has a remarkably strong lower frame, with trucks short enough to handle easily in places where ¾-yard shovels work, yet large enough to provide ample stability and balance. The base frame is a single alloy steel casting, heat treated. Instead of babbitt metal, brass lined bearings are used throughout.

The enclosed crawler, of new design, gives greater speed and extreme mobility. The propelling gears are self-cleaning and so protected that rocks, sticks, sod, etc., cannot fall onto the belt and pass into the sprockets. The steering is completely under the control of the operator from his seat in the cab. The new dipping device that acts with each digging cycle makes dumping easy and certain. The new Marion spacer prevents spreading of the dipper handle. The cab is all steel, roomy and well lighted. The large spring seat, easy lever action, metal locker for clothing, etc., and many other conveniences make for the comfort and efficiency of the operator.



New Anti-Friction Idler

Novo Issues Handbook

Novo Engine Company, manufacturer of engines, hoists, pumps, and combination outfits, is sending out the "Novo Hoisting Handbook," a manual of valuable information about hoists and hoisting work, with instructive illustrations and many useful tables of general interest to all concerned in the handling of the products of the pit and the quarry. Of special interest are the chapters treating of concrete handling equipment, the clamshell and derrick, industrial car hauling, dragline work, and the general handling, unloading, storage and reloading of sand, gravel, crushed stone and other materials.

THE 125TH YEAR

Portion of face of quarry at Birdsboro, Pa. 250 feet high and 900 feet long. Distance from edge to breaking line 40 feet.

The big shot in progress. The first time in this country that the well-drill holes and coyote tunnel loading methods were used simultaneously.

WAY OUT WHERE THE BIRDIES SING LOUDEST

—where the swish and bang of ponderous machinery sounds like an oncoming storm—there is where you'd better **know** what grade of rope you're using. Know in a way that only WILLIAMSPORT provides, Factory Certified—Telfax Tape proof. Chance taking under these conditions may knock profits into a cocked hat. The difference between profit and loss has kept many a man from buying that new equipment.

WILLIAMSPORT

is the only wire rope made, the grade of which is marked in plain English. This protection to you is worth more than the wire rope cost. Don't let carelessness enter into your daily work. Know what you are using.

Insist upon Williamsport.

WILLIAMSPORT WIRE ROPE CO.

MAIN OFFICE & WORKS: WILLIAMSPORT, PENNSYLVANIA
General Sales Offices: 122 So. Michigan Ave., Chicago

Use Madesco Tackle Blocks. They Stand the Gaff.

WILLAMSPORT
CERTIFIED WIRE ROPE

The General Excavator DRAGLINE

Same Boom used for Dragline, Crane and Clamshell

Full Revolving. 1/2-Yd. Dragline Bucket. Heavy enough to stand up to the work — Light enough to travel in Soft Going. Big Drums and Sheaves — easy on ropes. Big powerful Clutches — cool-running — positive in action — can be worked by a child. Powerful engine running at long-life Speed. All-steel "Press-Form" cab — fully enclosed. Built of Alloy Steel Castings. Easy to change to Crane, Clamshell, Shovel or Trencher. Bulletin 2703 tells you why The General leads the Field — a Demonstration will prove it.

General

GENERAL EXCAVATOR COMPANY, MARION, OHIO